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BUILD A TOUCH SCREEN GAMING PC

- Core i5-14600K + RTX 4080
- 4K Gaming Powerhouse
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28%
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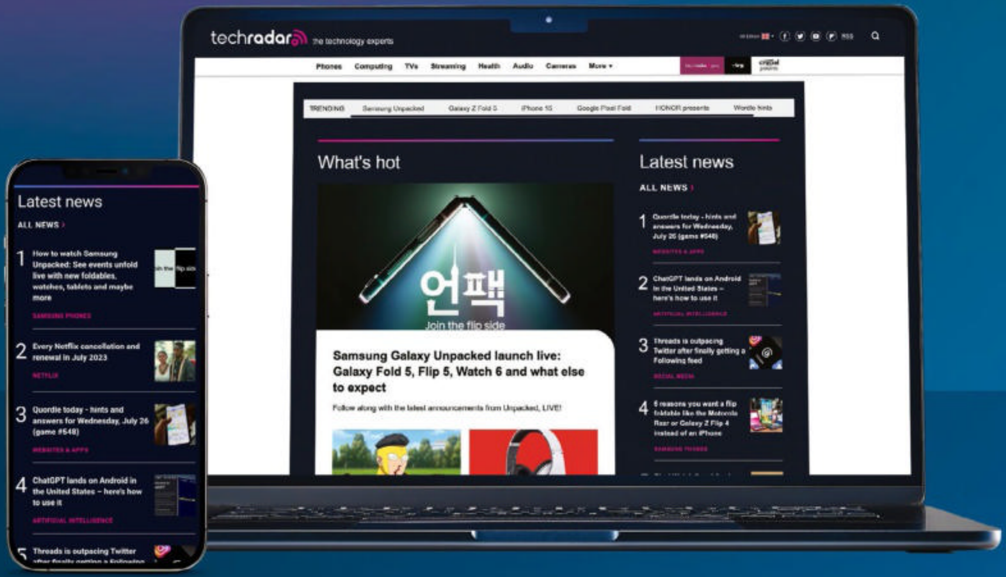
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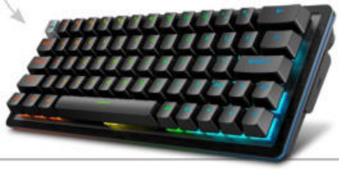

Not all gaming keyboards are created equal. What type of keycaps do you prefer?

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Guy Cocker

TOUCHING GREATNESS

WHEN IT COMES to building novel and visually compelling PCs, trust our ex-editor Zak Storey to deliver the goods. This month, he's put together a build using Hyte's Y70 Touch case, which incorporates a touch-sensitive LCD screen built into the case itself. It's not just a basic widget display that you might find on a modern CPU cooler; it's a second screen that plugs into your GPU. Zak says he was even able to help set up Windows using it, without having to plug into a main monitor first.

The components in this case are equally compelling, as Zak has tried to answer whether the Intel i5 processor is still the one to go for if all you care about is PC gaming. As a gamer myself, it's a setup I went for last generation: a 13600K paired with an RTX 4090—all my money spent on the best GPU possible, while trying to save on the CPU. Thanks to Zak's choice of case ($370) and lighting ($380), he hasn't quite gone down that route here, but he does tell you whether going 14th gen i5 ($320) or spending nearly double on an i9 ($600) is the way to go for 4K gaming.

With Zak now having done both an i9 and i5 build, next month we'll turn our attention to the i7-14700K. It's the most interesting CPU of the Meteor Lake lineup, offering more of a marked generational improvement than the i5 or i9 chips. It'll also be our first ITX build in a while, which Zak is excited about—how will Nvidia's monsterously big high-end GPUs cope? Also, be sure to check out our Story of the Build video by heading to our Cover feature, starting on page 16.

As I write this, I'm getting ready to head to Las Vegas for the Consumer Electronics Show 2024, which will be starting the day this issue is available. I've enjoyed a lot of pre-briefings, which of course are embargoed for now, but I'm excited to see lots of new laptops, displays, and graphics cards in the Las Vegas Convention Center. CES is also a great show for PC builders like us, with loads of cases, components, and premium builds for us to get inspiration for our own cover stars in 2024. Look out for our full CES report in the March issue of *Maximum PC*.

Back to this issue, we have a lot of Windows-related guides and features, addressing some of the requests I've received from readers (email me at editor@maximumpc.com). The first is a feature on what to do now we know Windows 10 support will come to an end in 2025, which you can read on page 42. The second is a guide for those of you who have made the leap to Windows 11, and that's how to use Microsoft's new Copilot AI features (page 58). We've also got lots on web browsers, from how to supercharge any Chromium-based browser on page 66, to whether Firefox beats Google's de facto browser in our Software Versus on page 92.

My favorite feature this issue, though, is how to stop using passwords. I'm a stickler for online security—I love doing a regular security checkup in my password manager, Bitwarden. But thankfully, with passkey support coming to most password managers and major mobile operating systems, the era of passwords feels like it's coming to an end. Find out how you can start enjoying better online security and stop worrying about storing passwords by reading our feature on page 32.

Enjoy the issue!

Guy Cocker

Guy is Maximum PC's *editor-in-chief. He built his first gaming PC in 1997 to play* Tomb Raider *on 3dfx, and has been obsessed with all things PC ever since.*

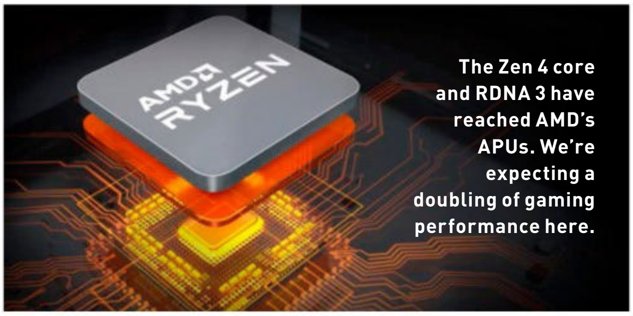
↘ submit your questions to: editor@maximumpc.com

THE NEWS

AMD's APUs go Zen 4

8000-series good news for budget gaming

WE'VE BEEN waiting for this one. AMD is finally getting the Zen 4 core architecture into desktop APUs. Previously, the only chips with integrated graphics and Zen 4 cores were built strictly for mobiles. These Phoenix chips are being made available for desktop duty in AM5 sockets, dubbed the 8000G series. As well as Zen 4, we get updated on-board graphics thanks to RDNA 3 GPUs. We're still running on leaks and rumors (expect more at CES in January), but we don't expect any real surprises when they officially drop. There will be a mix of Phoenix and Phoenix 2 versions. The former is a high-performance traditional design, while the latter is a hybrid design using a mix of Zen 4 and Zen 4c cores aimed more towards efficiency. This will be the first time an AMD hybrid design has reached the desktop.



The Zen 4 core and RDNA 3 have reached AMD's APUs. We're expecting a doubling of gaming performance here.

Details of four versions have sneaked out everywhere, as you'd expect ahead of a major launch. At the top comes the Ryzen 7 8700G. This Phoenix-based chip has eight cores, a top boost of 5.1GHz, and a Radeon 780M GPU, which has 12 compute units (equating to 12 ray tracing cores, 32 render output units, 48 texture mapping units, and 768 streaming processors). One step down is the Ryzen 5 8600G with six cores, a 5.0GHz boost, and a Radeon 760M GPU, which has eight compute units, and 512 streaming processors. Both feature integrated AI hardware. Then we switch to the hybrid Phoenix 2 architecture for the Ryzen 5 8500G with four Zen 4 cores, and four Zen 4c cores, while the Ryzen 3 8300G has four Zen 4 cores, and only three Zen 4c cores. This is pretty much the same chip as the Ryzen 3 7440U mobile part, but moved to the desktop, which gives us a good idea of the performance, although the extra power draw will help add frames. Both these use a Radeon 740M GPU with 256 streaming processors. These four chips have a TDP of 65W, and most sources also include two more variations: a Ryzen 5 8400GE and Ryzen 3 8300GE with TDPs of 35W for low-power applications. If budget gaming is your aim then the Phoenix versions are the ones to go for, with full-fat Zen 4 cores and much beefier GPUs.

AMD will pull the big reveal at CES on January 9, so we don't have long to wait for the full details, and silicon should be available soon after. No doubt we'll be treated to AMD's trademark slide shows with a set of orange bar charts showing just how good they are. Not all of this will be bluster either, as we already know roughly how good the Radeon GPUs are from their original mobile applications. This generation of APUs will double, possibly more, the graphical performance over the 5000-series APUs, which is good news for budget rig builders.

AMD has just had another chip launch, which may not be of interest to desktop builders, but is of huge importance to the company. The Instinct MI300X AI accelerator and the Instinct MI300A, the world's first data-center APU both appeared an AMD's recent Advancing AI event. Anybody making decent AI cards owns a goldmine, and Nvidia is selling as many as it can make—this is AMD's attempt to cut a bigger slice of the market. The MI300X contains more than 13 chiplets, many 3D-stacked, for a total of 24 Zen 4 cores coupled to a CDNA 3 graphics engine, all optimized for AI work. It's the biggest chip AMD has ever made, with 153 billion transistors. AMD reckons that the MI300X can offer up to 1.6 times the performance of Nvidia's H100 in inference work, and is a match for AI training. It's designed to be used in groups of eight, with 896GB/s transfer rates between GPUs and 10.4 Petaflops of performance in total. The MI300A combines CPU and GPU in one, and goes up against Nvidia's Grace Hopper Superchips, following the same basic design as the MI300X. In an opening speech at the event, AMD's CEO, Lisa Su, said that AI "was the future of computing", and that "maybe the only thing that came close was the introduction of the internet". Hyperbole? Maybe, but anybody capable of building AI silicon is building AI silicon, which should tell us something.

You may not be buying these two for home use, but if AMD gets this right—and it looks as if it has—it will make more than a small fortune out of these chips, which is good news for AMD's range. While Intel still looks to be dealing with a development stutter, AMD is forging ahead, and before next fall we should see the launch of the Zen 5 architecture with its overhauled design. AMD is selling more chips than ever, and according to Steam, 34 percent of users are running the red team's silicon. **–CL**

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WIN12 NEXT YEAR?

THE NEW WINDOWS MIGHT FINALLY HAPPEN

FOR A WHILE, it looked as if there would never be a Win12. Win10 was supposed to be the last version of Windows—from then on it was slated to become a subscription service. Then we got Win11, with the twist that it was a free upgrade. Now, we have another version in the wings. If rumors are to be believed, Win12 is due as soon as June, with a new interface. There are worries that it'll at least partly be a subscription service, or even have adverts (please no). Why the change of heart? AI. To get ChatGPT and other AI features embedded into the OS is a tough job for updates—it needs a fresh version. Comments from Acer's chairman in a Taiwanese enterprise publication alluded to accompanying AI rigs, too—the guess here is that 'AI PC' systems will be able to run AI functions locally, rather than via the cloud. This is made possible by next-generation hardware such as Meteor Lake, which has on-board AI acceleration. AI was an interesting experiment when Win11 was coded—now it's the next big thing, and Microsoft wants it front and center in Windows. Win12's hardware requirements should make interesting reading—will it be a replacement for those Win11 machines? **–CL**

COPILOT GETS GPT4 TURBO

This AI is about to get even more intelligent

MICROSOFT IS ABOUT TO UPGRADE Copilot's AI engine to GPT-4 Turbo, which is the latest version of OpenAI's ChatGPT engine. It's been trained on data up to April 2023, while its predecessor reached January 2022. It also has a quadrupled query size. GPT-4 had a 32K token query, Turbo has 128K. A token is roughly 250 to 400 words. This means you'll be able to dump about 300 pages of the average book into CoPilot and ask for a summary. It also has a code interpreter feature for programmers which will write and execute code in a sandbox. It can also summarize YouTube videos and rewrite text without changing the content. We also get Deep Search, which goes deeper into the web for more accurate results, although these take up to 30 seconds. There is also a new version of the Dall-E 3 image generator coming, too. Microsoft put $10 billion into OpenAI, giving it a 49 percent stake, and recently got itself a non-voting seat on the board after a rather public spat between board members. OpenAI is the commercial offshoot of an organization governed by a non-profit board, which is an odd arrangement. We expect that there's more pushing and shoving over the control of OpenAI to come. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

✓ **AI VOICES FOR GAMES**
EA has a patent for a technology enabling game characters to be voiced by AI systems.

✓ **DINOSAURS KILLED BY VOLCANOES**
The conclusion of an AI model set to find out why they died out without human prejudice.

✓ **DEEPMIND PREDICTS CRYSTALS**
Google's AI system has generated 2.2 million new possible crystal structures.

TRAGEDIES

✗ **SONY DELETES CONTENT**
PlayStation owners of Discovery shows will lose them thanks to "content licensing arrangements".

✗ **GOOGLE GEMINI CHEATS**
Test presented in real-time was actually made more slowly with text prompts. Sneaky.

✗ **AI CODE NOT SECURE**
A new report claims that cognitive bias leads people to trust AI code more than they should.

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NVIDIA SWERVES CHINESE SANCTIONS

Regulators not happy about it either

THE US GOVERNMENT has been restricting China's access to certain US-based technology. China is notorious for ignoring intellectual property rights, and it came as something of a shock to regulators when China's SMIC began mass production of 7nm ARM processors, with 5nm ones rumored to be not far behind. The focus of the ban is high-end AI processors, including GPUs. Last year's ban on high-end enterprise hardware such as Nvidia's A100 and H100 chips has been extended, with Nvidia's GeForce RTX 4090 included.

Nvidia was hit on sales, and prepared cards to avoid the sanctions. It built new A800 and H800 AI cards, fitting the same hardware as the banned cards, but with the NVLink interconnect turned down from 600GB/s to 400GB/s, giving them about 70 percent of the original's performance. The latest ruse is the RTX 4090D, which is designed to come in just under the sanctions limit by using a AD12-250 GPU, rather than the original A102-300.

This move didn't go down well. US Commerce Secretary, Gina Raimondo, who mentioned Nvidia by name, said that any card designed to circumnavigate sanctions is likely to be the recipient of particular scrutiny.

China is a lucrative market for Nvidia and other chip makers, so arbitrary limits are bound to produce hardware that skims just under. We expect spats between regulators and chip-makers to continue for years. This is a fight the US can't really win in the long run, as denying technology that is available elsewhere is next to impossible. What it can do is delay development by a year or two. In the fast-moving world of AI, that is a long time, but China will get there eventually. **–CL**

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WIN10 USERS TO PAY FOR SUPPORT

Home users need to upgrade or pay

WE ALL KNOW the story by now: Win11 was a free upgrade, but two thirds of the world's systems are still running Win10. Now, Microsoft has a more compelling reason for you to make the move: support for Win10 is coming to an end on October 14, 2025. After that, extended support is to move to a subscription model.

This is nothing new for commercial customers, who run lots of systems and don't want to interrupt operations. However, this is the first time the service will be offered to individuals en masse. The Extended Security Updates program is aimed at keeping systems protected, with no new features. This is going to be a little bit of a shock for people used to using Windows for free. There's no indication of prices yet, but commercial ESU licenses aren't cheap. Win7 Pro's ESU program was $50 for the first year, rising to $150 in the third (it finally ended in January 2023). Set the price too high, and it becomes a stick to beat those who won't, or can't, upgrade.

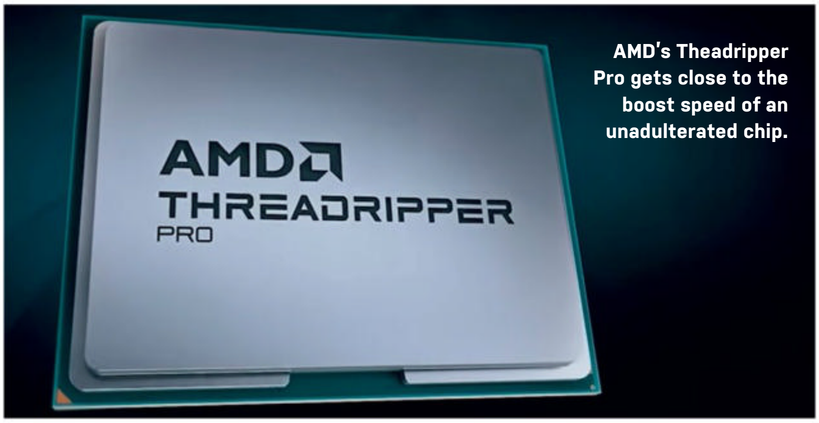
What we don't want is a lot of Win10 boxes running without the latest security updates, which will make a tempting target for the more maliciously minded. Before we get too indignant, remember that previously individuals only had limited access to the ESU program. Win10 users also have about 20 months to upgrade, during which time Win12 will surface, so you could jump an entire generation. Even if your system doesn't meet Win11's hardware requirements (reportedly 43 percent of Win10 boxes don't), there are 'workarounds' for the persistent. There's always a brouhaha when a popular version of Windows comes to the end of its life. Win10's popularity has earned itself a reprieve, even if it does look a little mercenary. **–CL**

Threadripper hits 6GHz on 96 cores

AMD'S ZEN 4 THREADRIPPER 7000-SERIES launched recently. There are two basic versions: the WX series, aimed at professional applications, and the X series for workstations and HEDTs. It was predicted to smash overclocking records. AMD's overclocking team got to work on the halo chip, the 96-core Threadripper Pro 7995WX. Liquid cooling pushed it to 5.0GHz, close to the boost speed of an unadulterated chip. This brought a few overclocking records, including on Cinebench R23 and 2024.

Then they brought out the overclocker's favorite weapon: liquid nitrogen. This reached 6.0GHz on all cores, while consuming 1,000W. It could now produce a Cinebench R23 score of 201,501. Others followed, topping that. The benchmark world records on HWBot that can usefully scale across multiple cores are dominated by the new Threadrippers. That Cinebench R23 record stands at 210,702 (so far).

Of more practical interest is the 'X' variant. This has been seen as a return to the HEDT market, which AMD left in summer 2022. Intel appears to have forgotten the HEDT—its X-series processors are all 10th generation and look antiquated. The rise of potent multi-core consumer chips effectively killed the HEDT. Then we get AMD releasing a new Threadripper X-series. The top chip is the 7980X, a $4,999 monster with 64 cores and a base clock of 3.2GHz. Then there's a 32-core 7970X at $2,499, and the 24-core 7960X at $1,499. You'll need a TRX50 motherboard, which are $599 to $899. There's not a lot of life in the HEDT market, and Threadripper alone won't revive it by much, but it's reassuring to know it's still there. **–CL**



AMD's Theadripper Pro gets close to the boost speed of an unadulterated chip.

The L2 RAM Disc

Fast storage means getting close to the processor. Hardware enthusiast and engineer Nemez realized that the L3 cache on AMD's V-cache chips was enough to mount a RAM disc within. A fast SSD on PCIe 5.0 can reach 14GB/s. Nemez's modified Ryzen 7 5800X3D managed 175GB/s writes and 183GB/s reads—a 12x bump. Even this hardly touches the theoretical throughput of the V-cache, quoted at 2.5TB/s on second-generation models. Creating this involved fiddling with parameters using OFSMount and CrystalDiskMark, and getting a workable disc volume out of of 96MB isn't easy. The process is tricky, but it shows potential other uses for that temptingly fast memory. **–CL**

AI ain't Green

We all know that cryptocurrencies chew through a lot of electricity, but now we have another piece of tech that is consuming power at an alarming rate: generative AI. A new report from Carnegie Mellon University and the French-American AI startup HuggingFace claims that large-model AI systems are power-hungry. This isn't surprising, but to see raw figures makes it seem more real. The biggest culprit is image generation. Creating around nine images uses enough juice to fully charge a smartphone (0.012kWh). Given AI's explosive growth, it looks set to need a lot of resources. Regulators are circling AI, trying to figure out best practices—perhaps energy efficiency should be part of that discussion. **–CL**

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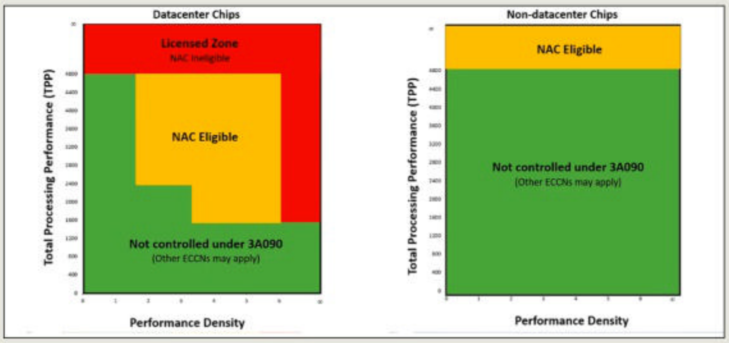
Jarred Walton

TECH TALK

RTX 4090 Banned in China

ONLY ABOUT A YEAR after the good ship RTX 4090 sailed out the doors, the US Department of Commerce has updated its export controls on various GPUs to prevent them from being sold to China. The RTX 4090 is now deemed too potent, due to its theoretical AI performance. The restrictions went into place on November 17, 2023, and the resulting chaos should come as little surprise.



Nvidia's RTX 4090 is now 'too powerful' to be sold in China any longer, along with many of Nvidia's latest data center GPUs.

The latest export restrictions on AI hardware define the limit as anything with a Total Processing Power (TPP) of 4,800 or higher. There's a secondary factor of Processing Density (PD—TPP divided by die size in square-mm) that seeks to limit data center parts so that supercomputers can't use lots of lower performance parts to make up the difference. Various GPUs, including the Nvidia H100, H800, A100, A800, L40, L4, and RTX 4090, can no longer be exported to China without a license—with a presumption of denial for license exceptions.

TPP is calculated by the highest teraflops or teraOPS throughput multiplied by the number of bits (eg. 16 for FP16 operations). The RTX 4090 has peak performance of 330 teraflops of FP16 compute using its tensor cores, giving a TPP of 5,280. That restricts it from sale—or manufacture—in China. Nvidia's L4 GPU accelerator has a TPP of 1,938 and uses the AD104 die with a 294.5 mm2 die size, giving a PD rating of 6.58, so it's also blocked.

To comply with the new restrictions, Nvidia created new products, but the Department of Commerce seems intent on blocking future parts as well if it deems them too powerful. Take the H20, which has a TPP rating of 2,368 and PD of 2.9, so it just barely complies with the announced limits. The problem is that it still has 96GB of HBM3 and 4 TB/s of bandwidth, so for LLMs (Large Language Models), it's still quite capable. It's almost like the US Department of Commerce didn't define the limits in a sensible way.

In response to the restrictions, there was a spike in Chinese prices on the RTX 4090, with cards selling for over $3,000. That led to profiteering as individuals bought up RTX 4090 cards, presumably with the intent of sneaking them into China. Combined with the added cost of not assembling 4090 cards in China, the result has been higher worldwide prices for the 4090—at the time of writing, the cheapest RTX 4090 listed on US sites like Amazon and Newegg now sits at over $2,200.

Numerous modified RTX 4090 cards—along with 3090 and 3080 cards—are popping up on places like AliExpress, the coolers replaced by blower-style coolers. In the case of the 3080, the VRAM has been upgraded to 20GB. This allows the use of multiple GPUs in servers, meaning groups within China are aware that it's possible to take consumer parts and turn them into faux-data center parts. They're also aware that memory capacity is often more important than pure compute for LLMs.

Nvidia is supposedly preparing an RTX 4090D for China that will reduce computational performance to comply with the export regulations, but those restrictions now appear to be a moving target. If an Nvidia L4 data center part can't be exported to China, why allow RTX 4080 and RTX 4070 parts to be sold? All they need is blower-style cooling, and they could be as capable as the L4.

It's not clear how this will play out, but given most graphics cards are assembled in China, it's potentially a double whammy. Of course, all of this ignores the fact that tens of thousands of H800 and A800 AI compute GPUs are already in China, not to mention even larger numbers of RTX 4090, 4080, and 4070 cards. I can't help but worry that we may be in for even higher GPU prices going forward.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

© U.S. DEPARTMENT OF COMMERCE

THE LIST

THE BEST GAMING KEYBOARDS

NOT ALL GAMING KEYBOARDS are created equal. What type of keycaps do you prefer? There's also the question of those all-important switches—do you like clicky or quiet, cushy or crisp? What about size, form factor, and extras like media controls and volume wheels? Do you want all the number keys, or as compact a keyboard as humanly possible? Don't forget about the wired versus wireless conundrum. Yep, there's plenty to consider when choosing your next input slab. Here are five of the very best…

5

WOOTING TWO HE

Look at the black faceplate and keycaps of the Wooting Two HE, and you might wonder what the fuss is about. It looks decent, but doesn't appear too different from most mechanical gaming keyboards. But it is, and then some, because it offers fully analog key control. If you depress a key, rather than send an on/off signal to your PC, the keyboard will measure the full range of motion. That's great for games like *GTA V*, where you often switch between running, driving, and even flying. **$195, www.wooting.io**

4

LOGITECH G915 LIGHTSPEED

The wireless Logitech G915 is a dream to type on. It comes with low-profile keys for a comfortable wrist angle, which makes all the difference. The 40-hour battery life with RGB per-key lighting (a little up from the full-size G915 due to the lack of RGB LEDs) keeps Logi's wireless tech in the good books, too. That's actually a 135-day battery life without lighting enabled, but who's counting? As a tenkeyless board, it's also pretty portable, and has a handy slot for storing the wireless dongle. That's a nice touch. **$230, www.logitech.com**

3

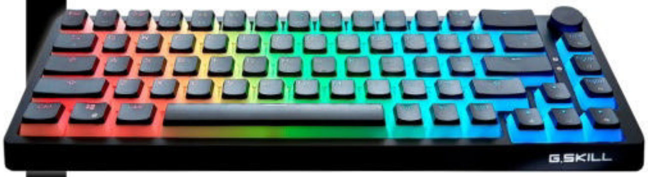
MOUNTAIN EVEREST 60

As a rule, we're not sure about 60 percent size keyboards for daily use. The Mountain Everest 60, however, is just as small and cute as the competition, and has all the enthusiast extras you could want, but has the total utility to be your daily driver of a keeb. In short, pun intended, Mountain has taken all it's learnt from its first keyboards, and created the best-feeling, most usable 60 percent gaming keyboard ever. It's solid, reliable, responsive, and offers the best typing experience around. **$140, www.mountain.gg**

2

G.SKILL KM250 RGB

The KM250 is an outstanding entry-level gaming keyboard, with the versatility to become almost an enthusiast typing board for less than the cheapest barebones kit. Mechanical gaming keyboards can cost a fortune—the G.Skill KM250 RGB's best trait is that it doesn't. Yet, it still offers mechanical switches, per-key RGB, hot-swappable keys, and discrete media controls. That's incredible for such a low price. **$40, www.gskill.com**



1

ASUS ROG STRIX SCOPE II 96 WIRELESS

There are faster, smarter, and cheaper boards that still deliver plenty of features, but the best all-round gaming keyboard has to be the Scope II 96 Wireless. That's in part thanks to lubed switches—yes, lubed switches in a mainstream keyboard. Every key drops lightly into place as you type, and smoothly springs back with a satisfyingly light clack. Wonderful. Lubed up, sturdy stabilisers also keep the larger keys, namely the spacebar, quiet. Delightful. **$180, www.asus.com**

© WOOTING, LOGITECH, MOUNTAIN, GSKILL, ASUS

Jeremy Laird

TRADE CHAT

We're to blame when our AI overlords arrive

NVIDIA IS CURRENTLY SELLING AI chips at a rate of about $15 billion every three months. By 2027, analysts predict that this figure will have doubled, taking annual revenues to about $200 billion, again for those specific chips used in data centers and excluding other income like gaming GPUs.

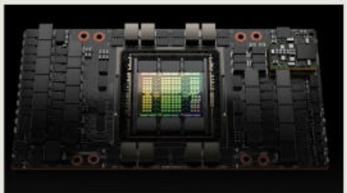
But as clever as Nvidia's CEO Jensen Huang is, it's a bit of an accident. The AI chatbot revolution, the whole large language model thing, is thanks to PC gaming—at least it is as far as Nvidia is concerned.

Almost everything about Nvidia's AI boom is kind of fascinating. It's intriguing, for instance, to consider who Nvidia's biggest customers are. You probably already knew that Microsoft was big on AI, so the fact that it's thought to have bagged no fewer than 150,000 of Nvidia's H100 AI-optimized GPUs in the most recent three-month period at a cost of around $5 billion isn't a huge surprise.

But did you know that Facebook is reckoned to have bought just as many? It's hard to imagine what they're doing with them all when they can't even get search routines in Facebook Marketplace to work properly. In both cases, it's three times as many H100 GPUs as Google and Amazon, who are each estimated to have bought about 50,000 units.

Their relatively lower uptake is probably related to the fact that they both commission chips of their own that do some of the work when it comes to processing AI workloads. With the eye-watering unit prices Nvidia charges for its H100 GPUs, thought to be $20,000 to $40,000 each, you can understand why the likes of Google and Amazon have decided, at least in part, to do their own thing. You also have to wonder if Nvidia's punitive pricing will end up hurting the company if everybody decides it's cheaper to make their own AI chips, or if the huge cost of Nvidia GPUs encourages customers to give alternatives like AMD's new MI300 a crack.

> The large language model is thanks to PC gaming, at least as far as Nvidia is concerned



Nvidia's H100 AI chip is a direct descendant of PC graphics cards.

© NVIDIA

Even if there are legitimate questions over pricing, Nvidia has done an amazing job. It's turned the company into a tech juggernaut. But don't go thinking that it's all part of a grand plan. I've been following Nvidia for a long, long time. I had my first contact with their PR department nearly 20 years ago, so I'd like to think I've got a feel for how the company presented its strategy, and how it saw its future in terms of what it publicly said about it.

20 years ago, it wasn't talking about AI. It wasn't even talking about it 10 years ago. Ultimately, it's serendipitous that the highly parallel nature of graphics chips lends itself so well to machine learning and large language models. That wasn't Nvidia's plan back when the company was founded in 1993. Indeed, Nvidia's current Wikipedia entry is suspiciously fanciful, speaking of Nvidia's co-founders envisioning, "that the ideal trajectory for the forthcoming wave of computing lay in the realm of accelerated computing,", as if they knew back then what was coming.

If they did, they kept it secret through those days of Riva and then GeForce graphics products. It was all about graphics, with barely a word about general computing, let alone AI. When Nvidia did eventually pivot to pitching its GPUs for general-purpose tasks beyond graphics, it was things like physics modeling, protein folding, and video encoding that were pointed to as killer apps for so-called GPGPU workflows, not AI.

Here we are in 2023, with dramatic strides being made, and I can't help thinking it wouldn't be happening, at least not right now, were it not for video gamers, and in particular PC gamers. It's us PC enthusiasts that drove demand for ever more complex GPUs. For better or worse then, whatever marvels or horrors the coming revolution holds, we only have ourselves to blame. Together, we are the parents of AI, and our offspring will change the world.

Six raw 4K panels for breakfast, laced with extract of x86... Jeremy Laird eats and breathes PC technology.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Raw file recovery
> Sub-100W GPUs
> AI graphics upscale

Data recovery question

A friend recently switched from Mac to PC, and made the mistake of somehow wiping his drive because it wasn't visible in Windows (as it had been formatted in Apple's own APFS format). He compounded the error by creating a new Apple APFS volume over the top of the original partition in a misguided effort to undo his original mistake. I've run several drive-recovery tools, but while they're able to see the drive's previous content, none of the files appear to be recoverable, even though no new files have been written to the drive. Why is this so, and is all his data lost?

—Eric L Dumont

THE DOCTOR RESPONDS: This comes down to the fact that most of the files in question have become fragmented over time. When fragmented files are deleted, even though only the first few bytes of the file are overwritten to leave the file contents largely intact until the space is overwritten with other data, there's no information in the file itself that records where the fragments reside.

That critical information is typically stored in the Master File Table (MFT), an area on the disk reserved for ensuring the OS can find not just where a file starts, but where it resides on the disk. This makes recovering deleted files from an existing partition a simple task, but when the partition is wiped, the MFT can be lost—this is certainly the case with older FAT/FAT32-formatted drives. NTFS backs up the MFT and stores these copies across the drive, making it easier to recover this information and improve the chances of recovering fragmented files.

However, the newest Apple file system (APFS) works differently to both NTFS and its own predecessor (HFS+). It seems that once the file system has been wiped and a new partition—even an 'empty' one—created on top of it, key information regarding the previous file system is lost. The drive's contents can be viewed, but the only way you're going to recover any data is through a raw file recovery.

The best tool for the job is DMDE (https://dmde.com/), which can read and recover data from Mac-formatted drives even from a Windows machine. Once installed, launch the program. Leave Physical Devices selected, select the external drive, and click OK. Next, click Full Scan, make sure Raw is checked, and click Scan. Wait for it to complete, then expand the Raw section to reveal a hierarchy of file types. Right-click each one, and choose 'Open Raw results only'.

A list of document types like Archives, Documents, and Graphics will be shown, inside each of which are related file types. Select one to view its contents, then double-click a file to view a preview. You can retrieve 4,000 files at a time from a single folder/file type in the free edition by right-clicking the parent folder and choosing Recover / Create File List, and following the prompts. Make sure you recover to a separate drive, and then the process of going through the list to identify and rename individual files can begin.

The GeForce 1650 is our GPU choice for power-conscious users.

© MSI

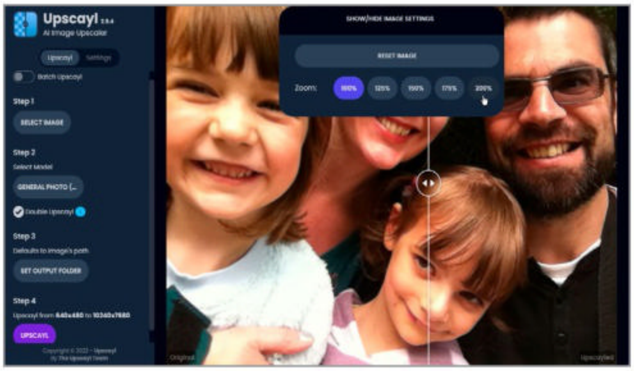
Low-powered GPUs

We don't see a lot written about graphics cards that don't cost a mint or burn electricity like a space heater. I have an NVIDIA GeForce 1050 Ti in each of my two desktops, but I rue the day when they fail (again). Is there a current-generation graphics card equivalent to a 1050 Ti that will run a 4K monitor and run on under 100 watts?

— John Weiss

THE DOCTOR RESPONDS: A superficial look at the current generation of graphics cards would suggest that there are no current-generation cards that meet your specifications, although the GeForce RTX 4060 comes close with a total graphics power rating of 115W. However, NVIDIA has started providing a range of power ratings for its 40 series models—and looking at these figures, the RTX 4060 is rated at 7 (idle), 11 (video playback), and 110 (gaming) watts respectively. This

↘ submit your questions to: doctor@maximumpc.com



The right AI model can produce miracles.

© UPSCAYL

suggests that in day-to-day use, you can expect the card to draw significantly less than 100W. Expect to pay $290 upwards for an entry-level RTX 4060.

If that's too high for your budget, then there's still plenty of choice—so long as you're willing to work with previous-generation tech. 4K support is well-established—your existing GeForce 1050 Ti cards already support it. If your budget is tight, then the GeForce 1650, introduced in 2019 and still widely available, should tick your boxes. It has 8K support and draws a maximum of 75 watts, even under load. You can pick up a MSI Ventus GeForce GTX 1650 for $149.99 at newegg (www.newegg.com/p/N82E16814137593).

If you want something newer, AMD's Radeon 6400 dates from 2022, and has a power draw of 53 watts, so it gets its power from the PCI-E port. With prices starting from around $130, it seems the obvious choice—however, cast your eye back to our review in the September 2022 issue, and you'll see we prefer the older GeForce 1650, particularly if your workflows benefit from hardware video encoding.

Identify network device

A few days ago, my Synology router started throwing up a flurry of notifications saying it had blocked access to a certain IP. The warnings refer to a hardware MAC ID, but no IP address. How can I identify where the request is coming from, so I can better evaluate it? **—Mary Metcalf**

THE DOCTOR RESPONDS: There are typically three things you can identify about network devices using software (or your Synology router): the IP address they've been assigned on your network, their uniquely identifiable eight-digit hexadecimal MAC address, and (if you're lucky) the device name or manufacturer. You can get this information from your Synology router by logging in to its web interface, navigating to Network Center, and switching to the Device List tab under Status.

Mary followed our advice, and was able to link the device's MAC address to its IP address on the network, manufacturer, and the fact it was connected via Ethernet cable. The manufacturer was revealed to be Microchip Technology Inc, which manufactures a range of semiconductor parts. As it's not known for producing specific products, this didn't help her much; however, it was likely to be linked to some network-connected piece of smart technology, so Mary was able to examine each piece of kit in her house to see if the MAC address was listed on its label.

This led her to her Sure Microchip Cat Flap Connect, or more precisely its hub, which transmitted the data recorded by the flap of her pet's incomings and outgoings to an app via the internet. With Synology blocking communication with a specific remote IP address, Mary had two options: whitelist that IP address in her router, or exclude the Connect hub so its traffic is no longer monitored by the router. This can be done via Safe Access > Security > Exception List tab. Click Add to enter either the remote IP address or that of your network device, provide a description, and click OK.

Rather than whitelist the unsafe IP address, which would put all Mary's devices at risk from traffic from that source, we advised her to whitelist the cat flap, and look at creating a dedicated VLAN, which would isolate the cat flap from all other network devices. If the cat flap is connected to the router, follow the guide at https://kb.synology.com/en-global/SRM/tutorial/Synology_VLAN_Deployment_QSG to configure it; if the cat flap is connected through a smart switch like TP-Link's TL-SG2008, you can configure the VLAN from there instead.

Installer error

I tried to install the latest version of OBS Studio, but it keeps failing with an error saying 'CefSharp.BrowserSubprocess' won't allow it. What is this, and how do I get past it?

—Thomas Stamper

THE DOCTOR RESPONDS: This file is part of the Chromium Embedded Framework (CEF), which basically allows apps to incorporate web-based elements in their own user interface. The error occurs because another program or process is using it.

We were eventually able to track the process to DeepL (www.deepl.com), an online and app translator. Closing the app via its system tray icon removed the block, allowing OBS Studio to complete its installation. From that point, both programs ran side-by-side.

If you find yourself in a similar situation, use Microsoft's Sysinternals Process Explorer (https://learn.microsoft.com/en-us/sysinternals/downloads/process-explorer). This lists all processes in a hierarchical structure, making it easy to trace one process to its parent using Find > Find Handle or DLL. Type 'cefsharp', click Search, then double-click the Process entry to view the process tree, with the culprit at the top.

Disappointing AI upscaling

I've been trying several free AI upscaling services, but they all seem determined to produce results that make it look like the subjects have over-sculpted their faces for social media. Is there anything that avoids these results? **—Joseph A Hughes**

THE DOCTOR RESPONDS: The Doc has been experimenting with an open-source, free desktop tool called Upscayl (www.upscayl.org/#desktop), which allows you to upscale photos to four times their normal size. However, while the default model—General Photo (Real-Esrgan)—delivers problematic results on many photos, another option called General Photo (Remacri) seems to produce more natural results. You can switch models using the dropdown menu on the main screen—Upscayl does, however, require a Vulkan-compatible GPU, so works best with discrete AMD and NVIDIA cards, although there is a workaround (https://github.com/orgs/upscayl/discussions/580) that should work for other graphics chips, including integrated Intel graphics, too.

Core i9 vs Core i5 How Much Power Do You Need?

THE CORE I5 HAS BEEN THE GO-TO FOR GAMERS FOR YEARS, BUT DOES THAT STILL HOLD TRUE?

INTEL'S 14TH GENERATION CPU launch has been, from a purely performance-jumping perspective, a bit of a boring one. Whether that's the lack of any actual hardware changes on the core of its lineup, or an underwhelming debut of its APO tech, it's a launch that's got a lot of us tech journalists really questioning why the company decided to launch the refresh when it did, particularly given the already potent CPUs it had in its arsenal. That got us thinking.

Last issue, we built a gorgeous top-tier gaming PC inside of the prestigious NZXT H9 Flow chassis, complete with all the best components we could find. The Core i9-14900K, the RTX 4090, a 1200W PSU, 32GB of DDR5, and a staggering $700 motherboard. It was, without a doubt, a bit of a monster. In 4K gaming it demolished everything we could throw at it, and when it came to benchmarking and real-world performance, there were simply no better alternatives out there at the time from AMD or Intel. If you wanted a versatile PC that could do everything from gaming to rendering, streaming and more, this was the machine.

The thing is, this was the very best hardware you could get, and frankly, if it couldn't do that, and cost you a clean $3,800 in the process, you'd probably be fairly frustrated, for lack of a better word. What we mean by that is that this hardware is expected to perform at this level. It's a given. If it didn't, we'd be crying into our thermal paste. But what about the lower-end skus, the ones that the vast majority of us will buy? What if we wanted to save a bit of cash, and drop down a few skus? How much would that affect performance?

For a while now, the Core i5 has been seen as the workhorse of PC gaming. If all you wanted to do was frag scrubs in *Battlefield* or defeat the Deathwing in *World of Warcraft* with 20 of your best buds, the i5 was the way to go. Elevate yourself to 4K gaming? Well, GPUs couldn't keep up with the frame rates, so CPU bottlenecks weren't a thing.

We've come a long way since then. GPUs have improved leaps and bounds from generation to generation, certainly compared to their CPU siblings. So does the old adage still hold true? Is the Intel Core i5 'enough'? - **ZAK STOREY**

INGREDIENTS

PART		PRICE
CPU	Intel Core i5-14600K	$320
Motherboard	MSI MEG Z790 Ace Max E-ATX	$700
CPU Cooler	Corsair iCUE LINK H150i LCD	$320
RAM	32GB (2x16GB) Corsair Dominator Titanium DDR5 @ 7200	$220
SSD	1TB Adata Legend 960 Max M.2 PCIe 4.0 SSD	$70
GPU	Gigabyte GeForce RTX 4080 Aero OC Edition	$1,300
Case	Hyte Y70 Touch - Red	$376
PSU	1200W Corsair RMx Shift 80+ Gold	$230
120mm Fans	2x Corsair iCUE LINK QX120 Starter Kits (6 fans)	$320
140mm Fans:	1x Corsair iCUE LINK QX140 Fan	$65
TOTAL		**$3,921**

PRICES CORRECT AT THE TIME OF PRINTING

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CPU Core #1 Thread #1
11%
CPU Core #1 Thread #1
11%
Used Space
83%
Memory
28%
GPU Core 42%
GPU Core 30°C
GPU Core 210MHz
54°
Clear
H: 71.8° L: 50°
Los Angeles, California
10:37pm
8:44am
MEG
CPU Package
47
VERO

Hardware Picks

CPU $320

Intel Core i5-14600K

The Intel Core i5-14600K is the little brother in Team Blue's 14th gen product stack (we're yet to see a Core i3 make it to market just yet). That said, it still packs some serious punch on the performance side of things. By default, it comes with a total of 14 cores. Six of those are Intel's Performance-cores, complete with hyper-threading, the remaining eight are the 'Efficient-cores' designed for desktop applications. It clocks in at a max turbo frequency of 5.3 GHz, but other than the 200 MHz bump to clock speed, is identical to the Core i5-13600K. It doesn't even get access to APO.

That said, it's still a potent chip, and comes with all the other bells and whistles you'd expect from a 13th gen product. It's just a shame that it's half the chip at more than half the price of its 14900K counterpart at the top. **www.intel.com**

MEG
LGA-1700
ACE
MAX

Motherboard $700

MSI MEG Z790 Ace Max E-ATX

Another top-tier $700 flagship motherboard has landed with us, and this time it's MSI's premium ACE option. We wanted to keep the motherboards fairly similar to ensure a fair testing platform for the CPU and GPU swaps here, but this is still a potent board that shouldn't provide any bottlenecks. In fact, compared to the Core i9 build from last issue, this board does have slightly more power phases (24+1+2 vs 20+1+2), but given the Core i5's significantly lower stats, this is highly unlikely to give it an edge competitively.

Otherwise, you get some incredible I/O: dual 2.5G ports, some impressive cooling, WiFi 7, plenty of PCIe 5.0 SSD slots, and some really unique quality of life improvements for system building, too, although more on that later.

One more interesting thing to note is that this isn't even MSI's most expensive build. That honor is reserved for the GODLIKE and GODLIKE MAX, both clocking in at $1,200 a piece. **www.msi.com**

RAM $220

32GB (2x16GB) Corsair Dominator Titanium @ 7200

Another Corsair part added to our arsenal this issue, and one held up in shipping hell for the last build is this 32GB kit of Dominator Titanium memory. It's a bit on the pricey side, but at 7200 MT/s, it represents one of the best memory kits you can buy, complete with tight timings, and some impressive aesthetic design, too.

You can also pick up a kit with copper heatspreaders, or 3D print your own toppers, which is particularly useful if RGB isn't your thing.

Just be warned: if you're looking to build an AMD system, and want a kit, make sure you buy one of the AMD EXPO approved kits, as it's unlikely to be stable when XMP is activated on an AMD board, and you'll have effectively spent all that money on a 4800 MT/s kit. **www.corsair.com**

GPU $1,300

Gigabyte GeForce RTX 4080 Aero OC Edition

Say hello to the Gigabyte Aero OC Edition RTX 4080, arguably the biggest card we've ever seen. This thing is an absolute monster, complete with a twin cooler design, airflow passthrough, and a 'support bracket' that requires you to attach the entire rear of the graphics card on the motherboard standoffs as well. We won't be using that in this build, as that's not something the case supports, but even so, given how big these things are getting, and the more outlandish the support solutions are becoming, we have to question where it's all going to end.

We stepped down from the RTX 4090 to the RTX 4080 for two reasons. Firstly, to see if that old adage was true—that 4K gaming is too intense and a CPU doesn't matter for lower-end cards, and two, to see how big the performance difference is between the RTX 4090 and a card that's only $300 cheaper. In an ideal world, you'd 'probably' pair an Intel Core i5 with something like a 4070 or 4060 Ti, and that's the second question we wanted to answer. Does that matter? **www.gigabyte.com**

Case $370

Hyte Y70 Touch

Hyte took the world by storm last year with the Y60 chassis. The Y70 Touch is the evolution of that case, and with it comes some seriously cool improvements. This is without a doubt one of the best cases we've ever had the pleasure of building in. From thoughtful quality-of-life design touches, to the crisp build quality, a powder-coated finish, and of course that beautiful screen baked in, it's a true thing of beauty.

It's not without fault, of course. There are things that could be improved, and design decisions that you'll see during the build process that did confuse us a touch, but if you're looking for something radical and a bit different, then this might just be the case for you. **www.hyte.com**

PSU $230

1200W Corsair RMx Shift 80+ Gold

We've gone with the RMx Shift again for this build for two reasons. First, to make better use of it than in the NZXT Flow case from last issue and the cramped building conditions it led to; and second, for what's going to happen to this system after the fact.

For those that didn't read last issue, the one trick the Shift has in its arsenal is its rotated ports. All the modular cable connectors are on the side of the unit, rather than tucked away under the PSU cover in any traditional chassis. In a normal case, that makes it easy to access your cables just by taking the side panel off. This means no more rooting around in the dark trying to install another PCIe power lead, or removing the PSU entirely when you need to plug in an extra fan controller.

We'll show you the second part at the end of this build log. **www.corsair.com**

Cooling $375

Corsair iCUE LINK QX Fan Starter Kits

To complement our iCUE LINK escapades, we've got no less than nine fans in this build total. Eight of those are 120mm variants, and we've got a single 140mm variant in the rear. To achieve this, we got in two starter kits from Corsair (each comes with a hub to connect everything to up to 14 devices per hub, seven per channel), plus an assortment of iCUE LINK cables of varying sizes and angles.

The H150i also comes with three identical QX fans, plus hub and cables as well, to add to this endeavor.

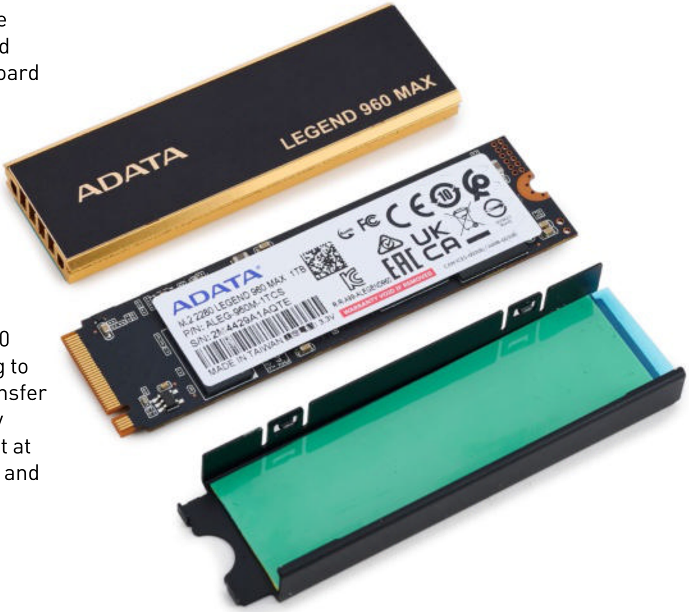
Aside from the magnetic daisy-chaining, single fan cables, and pre-installation in blocks of three, each fan has its own thermistor, so it can detect the temperature of the air passing over each unit, all of which is logged in iCUE—neat, huh? The caveat? It's stupidly expensive. **www.corsair.com**

SSD $70

1TB Adata Legend 960 Max M.2 PCIe 4.0 SSD

We've gone for the same SSD as the last issue for two reasons. First and foremost, similarly to the motherboard pick, we're trying to keep it fairly consistent in the other variables department. Secondly, our first SSD of choice for this build, the Samsung 990 Pro, is currently sat in Taipei in an airport, unable to get to us for some reason.

That said, the Adata Legend 960 Max is still an impressively affordable and good-value SSD. $70 of 1TB PCIe 4.0 goodness is nothing to sniff at, particularly with 7GB/s transfer speeds. If anything, you're probably better off picking up the 2TB variant at $137 for just for a bit more comfort and capacity. **www.adata.com**



CPU Cooler $320

Corsair iCUE LINK H150i LCD

At Computex this year, Corsair announced one heck of a product stack in the form of iCUE Link. It's an interconnected daisy-chain system that allows you to connect an arsenal of premium top-tier components together with ease, all to one centralized unit, and with just a single cable.

The H150i LCD is a recent addition to that range, taking the 360mm designed coolers Corsair is known for, and adding that additional compatibility. Outside of the expected performance you get from a rad of this size, the one added bonus is the lack of cabling coming from the CPU block. No longer are we bound to awkwardly routing pump cables around heatsinks and VRMs. On top of that, it comes with an LCD display, configurable to whatever stat or graphic you want to chuck on it, not that we need it in this particular PC case. Even the fans are pre-installed. **www.corsair.com**

David vs Goliath – i5 vs i9

Difficulty MEDIUM
Time 1 - 2 HOURS

THIS BUILD IS a bit of a unique endeavor. The key question is fairly straightforward: is the Intel Core i5-14600K still a good CPU if all you care about is gaming? That's a bit of an oversimplification of things, of course. After all, there's more to it than that. In a world of expectations and assumptions, your average tech journalist or PC enthusiast would pair an Intel Core i5 with something like an RTX 4060 Ti, or an AMD Radeon RX 7700 XT, or similar. But does pairing it with something like an RTX 4080 or 7800 XT dramatically alter the performance of those parts as well? That's what we're looking to answer here. It's an odd pairing, we admit, but its that very oddity that makes it an enticing question to answer. For the longest time, we've argued that 4K gaming is almost always limited by the GPU, rather than the CPU. Does that old adage still hold? Can you get away with pairing a Core i5 with an RTX 4080?

On top of that, there are two other key areas we wanted to take a look at with this build; two key product lines. The first is Hyte's brand new Y70 Touch chassis, in all of its $380 glory, complete with an over-the-top portrait display. Secondly, Corsair's iCUE Link PC building ecosystem (Corsair's buzzwords, let's be fair, we prefer to call it daisy-chaining). Is it easy to use? Simple? Useful? Or an overly expensive luxury that doesn't warrant the cost? You could probably add that same query to the embedded screen Hyte has integrated with the Y70, but more on that later.

This is, on the surface, an overly expensive build. In fact, compared to last issue's super high-end RTX 4090/Core i9 build, the price of this machine is several hundred bucks more, which is nothing to be sniffed at. Again, most of this is down to accessories that really don't impact performance much, if at all: an expensive motherboard, over-the-top cooling, a big flashy case, high-speed memory, a 1200W power supply and other such frivolities. Comparing this build to last issue's on price alone is akin to comparing a Ferrari Dino 206 to a 67 Pontiac GTO. Sure, it's glamorous, flashy, looks the part, and performs well enough, but it just doesn't have the same straight-line grunt that the i9 build has, or the same charm in its pursuit of frames. This is more about turning heads than it is exceptional performance.

That said, you could easily strip back some of those areas, and still end up with similar performance for a lot less. Drop the memory frequency, the motherboard price, the chassis and cooling, and you could easily bring this down to the $2,500 range, no sweat.

Touch teardown

The Hyte Y70 Touch is a unit of a chassis. Complete with E-ATX support, beautiful grommets, incredible cooling support, and some seriously cool added extras, it's an epic case to build in. iBuyPower (Hyte's parent company) knows a thing or two about building systems, and it shows. That said, the process of building a system remains the same.

First and foremost, it's about removing as many panels as we can and storing them for later to keep them safe during the build process. The traditional side glass window has pop rivets at the top, which you can see in **STEP 1**. Simply get your fingers to the rear of the panel and pull away. Those pop rivets will, er, pop, and the panel will be able to be removed. Repeat for the roof and the rear panel, set them aside, and you'll be good to go. The frontmost panel and the display are fixed in place. Both are removable, but you can leave them there for the time being.

This is to go even further beyond...

Dragon Ball Z references aside, we're going to continue the stripdown on this build with one extra step. By default, Hyte has included a PCIe 4.0 riser in the Y70 Touch (and in the Y60, for that matter). It's secured in place twofold: once on the half-height (yep) PCIe slots you'd find in a traditional case, and once with a small bracket where the PCIe slot connector is on the bottom of the chassis.

Simply remove these screws and the securing plastic bracket, and set aside for later. You could theoretically leave this in for the time being, but it'll be more awkward to get the motherboard in and maneuver around it, so we recommend pulling it out now **STEP 2**. You can also see the DisplayPort passthrough for that screen. Yep, that's running directly under the chassis to that display screen. Here, you plug in a DisplayPort cable directly from that passthrough to your GPU, and voila, extra screen. This is a full bloom device as well. No widgets, no

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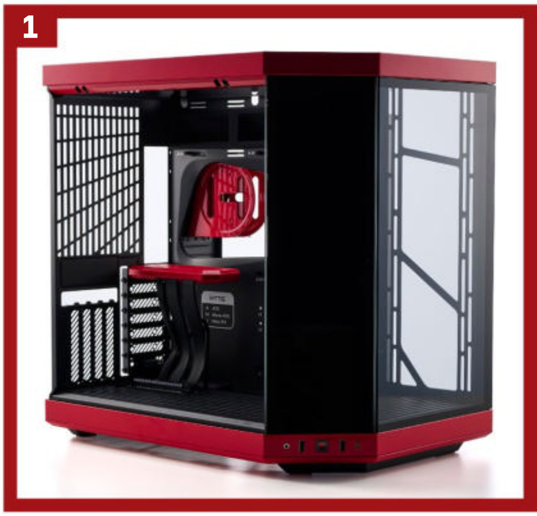

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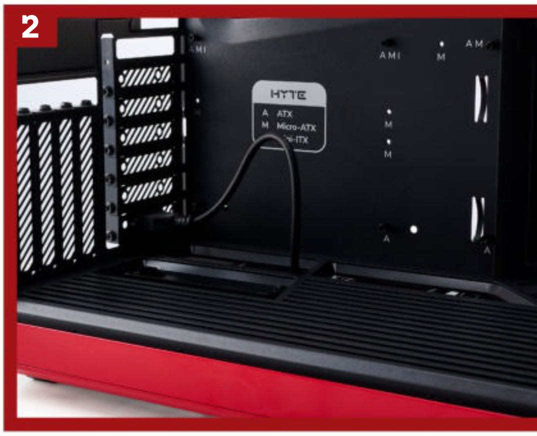

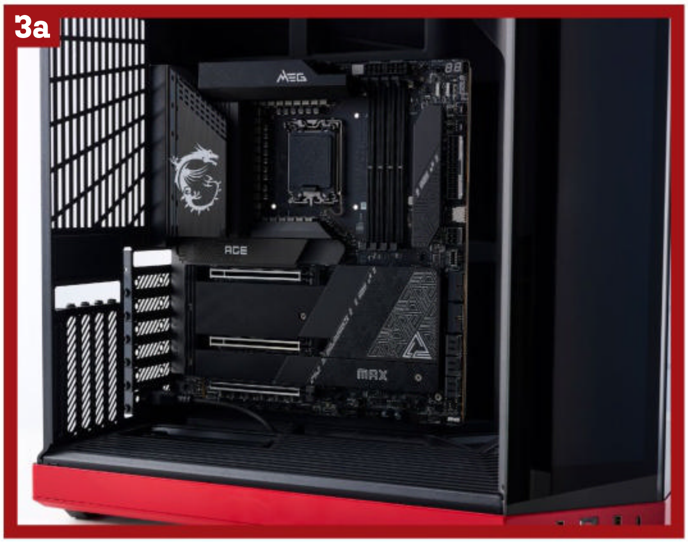

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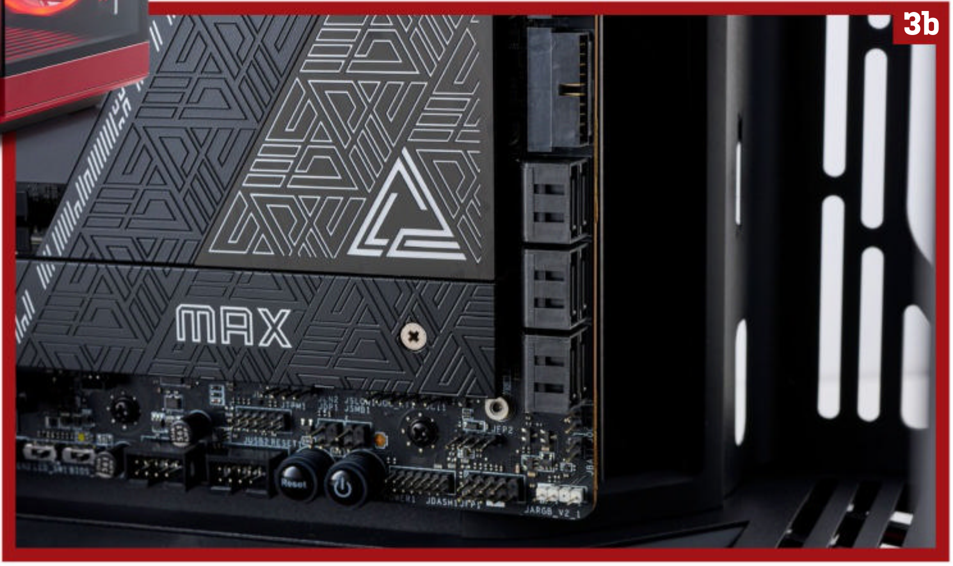
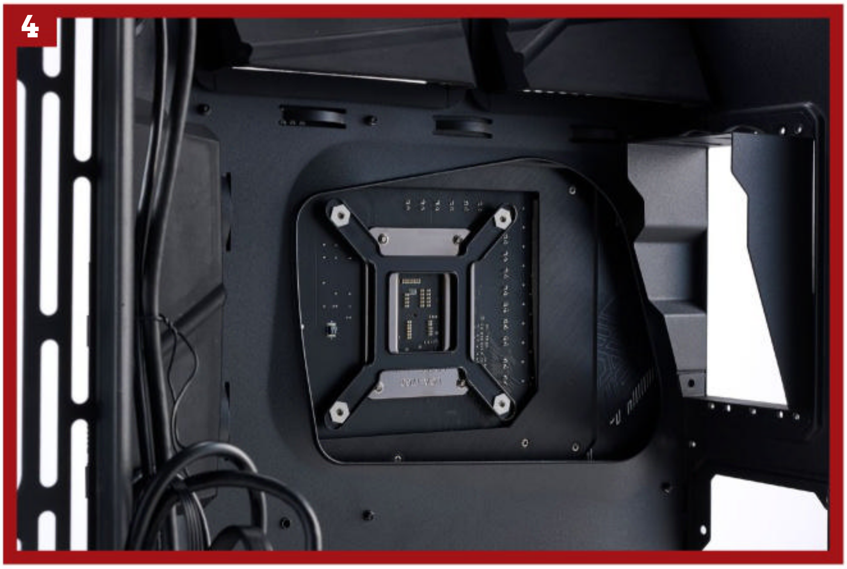


3b



4

USB interfacing with the motherboard (although it is powered via USB)—a literal screen on your case.

Can we take a moment to appreciate the subtle details Hyte has included in this chassis as well? Particularly all the markers to identify the stand-offs, and the detailing literally painted onto the motherboard backplate itself. If it's not obvious, we like this case.

E-ATX overhang?

We've gone ahead and installed the motherboard barebones. There's no preliminary prep-work here. Given the size of the case, clearances, and hardware we'll be using, we've pulled the trigger, and are going to be installing everything directly in the chassis itself **STEP 3A**. One slight caveat to making this decision if you do decide to go that route is to make sure your case has a big enough motherboard tray cutout for you to get your backplate in position for your CPU cooler. As with other chassis, carefully line your motherboard up with the stand-offs, place down, and secure into position with the included screws that came with the case.

By default, the Hyte Y70 Touch prefers to support ITX, Micro-ATX, and ATX motherboards. However, due to the size of the case, it does also support E-ATX as well, albeit with a caveat—namely, you're going to end up with a slight overhang **STEP 3B**, and won't be able to secure the motherboard and the right-most standoffs. That's fine—just be careful when you're installing your cables on that side. Make sure you're supporting the underside of the board pressing against whatever it is you're installing. The Y70 Touch also has diagonal cable grommets here (more on those later), so you'll always have cable clearance.

Motherboard cutouts & iCUE LINK

Here, you can see what we were talking about earlier with the Motherboard cutout. Fortunately, the Y70 Touch has a humungous cutout specifically for this. We've gone ahead and pre-installed our H150i cooler's backplate **STEP 4**, as next, we're going for the jugular and playing around with Corsair's iCUE LINK system.

Next up, we're on to cooling, as we've got a lot of fans to install. The plan is simple: three in the bottom, three on the side, one in the rear, and three in the roof (the AIO). We'll be running the bottom three as an intake (these sit hidden under the GPU floor), three on the side as exhaust, three in the roof as exhaust, and that rear one as exhaust as well.

In an ideal world, we wouldn't technically do that, as it'll lead to a negative pressure system, and boy does this case have holes in it that aren't filtered. But with some clever tweaking and fan profiles in iCUE, we can adjust that, and set multiple profiles to each fan set to balance it out, while still looking cool (because let's face it, nine fans in a case is overkill, anyway).

Fan brackets, fan brackets everywhere

We have brackets, and we have lots of them. STEP 5A is a good example of that. This is the one underneath the chassis. To access this, flip the case onto its roof, remove the slide in dust filter (it's got a simple tab clip that you release it with), and then undo the three thumb screws and slide it out.

You'll see a fixed floor (sitting under the GPU) that allows plenty of air to pass through along with some cables as well. Now, hindsight is 20:20 and also, not very useful for us in print. According to Hyte, the Y70 Touch supports, three 120mm fans in the bottom, or two 140mm fans. For the life of us, on first build, we just couldn't get three 120mm fans installed, no matter what we tried. We took the chassis home, did a bit of tinkering, and voila, three fans were successfully installed. Annoying, huh?

We've pre-installed the fans here, removing the third one for the time being. Corsair's LINK fans are magnetized together, and have special clips for each unit that daisy chain in between without a cable. It's smart, effective, and very clean. The advantage of that last part is that because they make such a solid connection, you really don't need to secure every screw in place for the fans. To that end, we've only secured the four here STEP 5B, one in each corner of the block. This makes it easier for us to remove and adjust these if we need to at a later date (say, for routing cables, or adding an additional fan that definitely didn't fit).

Resecuring PCIe passthroughs

This is a $380 case. It's arguably one of the best cases I've ever built in. This STEP 6A is the PCIe 4.0 passthrough. It's plastic, bright red (admittedly to match the case colorway), and looks cheap as hell. It's one small (pedantic admittedly) area that really lets the case down. It could have been kept cleaner, or made to look better, or given a soft rubberized black finish. Admittedly, once the GPU is in place, you can't really see it, but it's still a frustrating let down. We were half-tempted to take a can of black plasti-dip to it to hide it a bit better. Installation is much the same as removal, just in reverse. Secure the base back into position on the bottom of the case using the screws you removed earlier, re-attach the small plastic bracket that helps route the cables, then install the top passthrough cheap plastic red block thing (definitely not salty), into the PCIe slot you want to use, and secure it as if it was a PCIe device.

One nice little thing we do want to highlight, though, is that Z790 ACE MAX's PCIe 5.0 M.2 slot above it. That is really cool. There's a tiny magnetic latch at the top left of it that you simply press down to remove. It's an incredibly overcomplicated piece of engineering STEP 6B. Does it initially confuse things? Yes. Is it bumping the price up of the motherboard? Probably. Is it cool? Still yes.

PCIe inflexibility

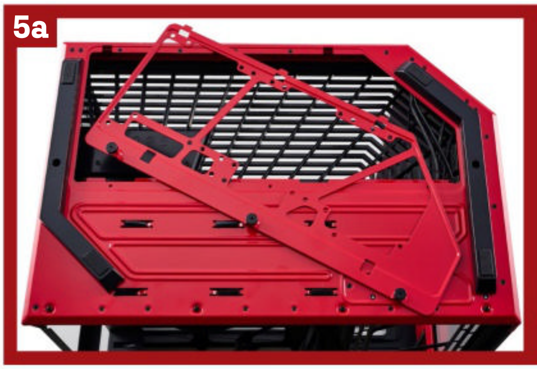
After that, we installed our M.2 SSD. Simply slot it into position, rotating the small plastic latch around to secure it, then reinstalling the heatsinks making sure to remove the plastic cover on the thermal pad, and re-engaging the locking mechanism.

One thing we do want to highlight here is the half-height PCIe slots. Yep, that does mean you can't install your graphics card in a traditional manner. You'll also have to be wary if you have any additional add-on cards, such as chunkier soundcards, network devices, capture cards, or M.2 RAID cards.

We get why Hyte went this route with the chassis. It does look incredibly clean, and for the average gamer, having that vertical mounted GPU looks classy as heck, but having a rotatable or removable bracket (particularly at this price point) that we've seen from some manufacturers, would give the end-user a lot more flexibility in terms of how they mount their hardware.

Core hardware goes in

Now we've got that moaning out of the way, we're onto the core stuff. First is the CPU. To install your Intel LGA1700 CPU, lay the case down on its side, and then carefully lift up the retention arm STEP 7 on the right of the socket. You'll need to push it down and to the side, then move it up. That will lift the top-most clip. With that clip up, lift up the protective cover and socket bracket. Once the cover and socket bracket are up, place your CPU into position. Notice the triangle on the image? Align the golden triangle on your CPU with where that is in that image, and carefully lower the CPU into position. There'll be notches on the socket to help here, too.

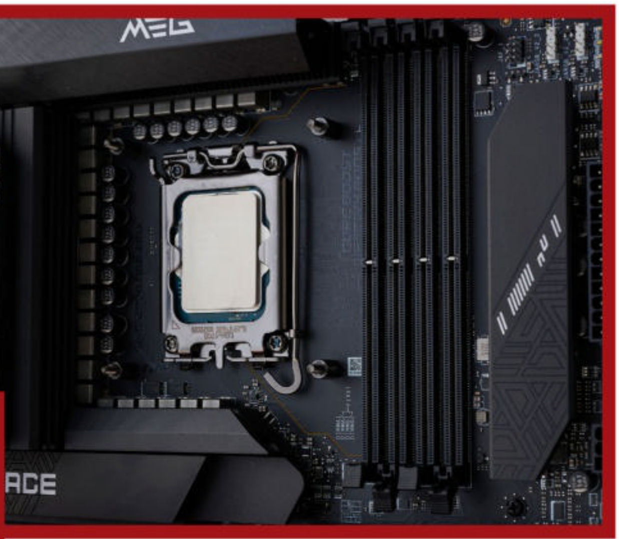

5a

5b

6a

6b

7



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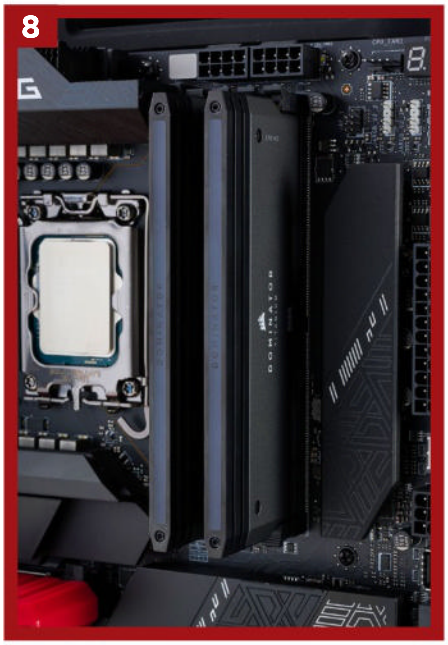


9

10

Once your CPU is seated and snug, reverse the process, lowering the bracket back down, and resecuring the retention arm. Once you do that, your protective cover should pop off. If it doesn't, you can pry it off with your fingers, and you have one secured CPU. One thing to watch out for is to make sure the bracket is secured. There's been a few times where we've thought it was under that little bracket arm at the top, and it hasn't been.

Memory goes in

Next up is that shiny expensive memory. MSI's motherboard only have the one latch for its memory slots, and we'll be using the pair the furthest away from the CPU itself. Simply unclip the latch at the bottom of each slot, and then carefully align the sticks of RAM with the notch in the DIMM slots. Generally speaking, if you're unsure, the label with all the timings and warranty info on the sticks of memory should be facing closest to the CPU, with the 'pretty' branded side facing closer to you if you were looking at the PC directly. Those marketing gurus know what they're doing when it comes to subtle advertising **STEP 8**.

After that, it's time for the power supply. Head around to the back of the chassis, and you'll see Hyte have placed the PSU mount in the bottom of the chassis (unlike NZXT from last build). This is useful, as it gives us space underneath the PSU, as well as above, to route our cables.

There's a huge amount of space here for us to route these cables, but for once, having the Shift in a chassis like this actually helps a lot, as the cables are now pointing directly upwards, and it's a lot easier for us to route the bulk of them up and out **STEP 9**.

Fan time

We've also gone ahead and installed some of the fans, along with doing a bit of cable routing, namely the triple exhaust fans on the side of the case. Now, similarly to the bottom-mounted fans, we've attached these at each corner of the 'block' of fans, along with two in the middle.

At this point in time, and because we've not routed these cables just yet, it's worth keeping these fairly loose. Not loose enough that they fall out, but loose enough that you can move the block of fans up and down if you need to, in preparation for shifting them around for your upcoming cable management **STEP 10**.

What happens when?

Your photographer accidentally drops a $4,000 camera onto concrete (faulty tripod), panics, and breaks a trigger on it. As a humble PC builder, while said photographer is panicking, what's the best thing you can do? Keep your mouth shut and keep building, and that's exactly what we did here, which is why we've got a lot of install shots straight after STEP 11A. We've gone ahead and installed the CPU cooler here. The H150i is a bit of a beast of a radiator, but it does come with a few caveats that you need to think about before installation.

Unlike the majority of the iCUE Link components, the LCD cooler is a bit of a faff. It has a cable hub at the end of it, and to that, you need to connect the fans for the radiator, then run a cable off that to your next iCUE device. Additionally, you need to run a USB cable from that hub to a special 2x USB A to 1x USB A adapter. (One of these will connect to your iCUE LINK commander unit, then to your motherboard.) That requires a bit of thought ahead of time.

So at first, we didn't worry about the cable installation; we simply installed the H150i Elite onto the removable bracket, by removing the two internal thumb screws from the rear of the chassis, lifting the bracket out, installing the AIO, STEP 11C, then carefully lowered it down into position. After this, we went about the usual AIO CPU block installation procedure (check you've got the right bracket, and thumbscrews). Make sure you've got a good dollop of thermal paste in position, then secure down in a diagonal pattern STEP 11B. With that done, we installed the rear 140mm fan, and got to work on figuring out the cabling STEP 11A.

The eagle-eyed among you will have spotted that we've actually threaded the AIO tubing towards the rear of the chassis. We did this on purpose, as that's where that cable hub is. The logic is simple: run the AIO fans to cable hub on the radiator, then the radiator to the 140mm fan at the top. Then, that 140mm fan to the LINK hub around the back of the chassis. This would be our first 'lane' on the hub. (Each side of the LINK hub can support seven devices total, and this would amount to four). Then on the other side we ran a cable from the floor fans, around to the bottom of the triple side exhaust fans, then from the top of that into that same LINK hub, in the back of the chassis totalling five devices on that line, and still giving us plenty of wiggle room.

In STEP 11D you can actually see how tight this area is in the chassis itself. If we're honest, we're still not 100 percent happy with how this cabling ended up. Post-build, it's definitely an area that could do with a tweak to hide those cables a bit better.

More cables

Surprisingly for a build that's taking advantage of a cable-less system, it's actually required a bit more thought than usual. It might sound odd, but although the LINK system does simplify system building, it requires readjusting your brain a little. Instead of connecting components directly, you're now having to think serially, and yet still work within those limitations set out by Corsair (seven devices on each line). It's highly worth drawing out a rough 'wiring' diagram so you can figure out exactly the best way to link everything up.

After that was all wrapped up, next was the far simpler PSU cabling. We decided it was far smarter to install the PSU cables next, and pre-route the GPU 12VHPWR as well. We went ahead and installed the 24-pin STEP 12A as usual, making sure to support the underside of that overhang on the E-ATX board, then installed the EPS power, as well as the front panel headers. This time around, we're not bothering with the front USB headers or audio-passthrough, so we've strapped those up and left them buried in the bottom of the chassis.

After that, it was simply a case of wrapping up the LINK cabling, running those bottom fans into the triple exhaust, and up and round into the LINK hub directly. That then plugs into the USB two-way adapter, then directly into the motherboard, and lastly, we have a single power cable for that going into a PCIe power STEP 12B.

We haven't gone too crazy with the cable management in this build, mainly because there's just so much room back here to store the cables, but to be quite frank, given the space, you don't need to be super tidy.

GPU and Hyte shenanigans

Lastly, it was a case of installing the graphics card STEP 13A. We removed the necessary vertical PCIe covers, and carefully placed the GPU in, securing it as we did so from the rear of the case. Then, after installing the 12VPWR600 cable securely, that was pretty much it.

There was one last thing we needed to do to get that screen working, however. The display in the Hyte Y70 Touch, is a full touchscreen 1100x3840 IPS panel that runs at 60 fps. It's an incredible piece of kit, but to get it working, it needs to connect directly to your graphics card. To do that, Hyte has included a passthrough at the rear of the case, along with an adorably short DisplayPort cable as well. Plug that in the passthrough STEP 13B, and you're all set.

11a

11b

11c

11d

12a

12b

13a

13b

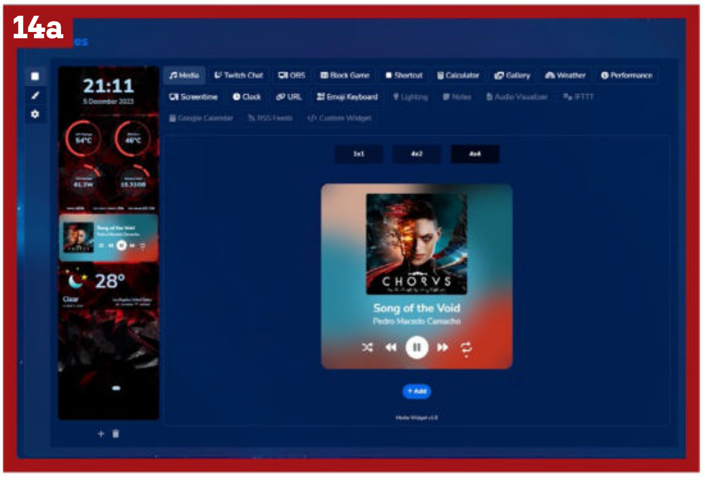
Display configuration

Hyte is developing some seriously neat functionality for this little touchscreen, too. By default, it comes with a number of set profiles you can activate with animated backgrounds. Alternatively, if you don't like the extra CPU load, you can use a static image, and customize it yourself.

On top of that, it has system monitoring, and a whole plethora of other widgets, games, calculators, and apps you can chuck in as well, including support for OBS, Twitch Chat, program shortcuts, and more **STEP 14A**.

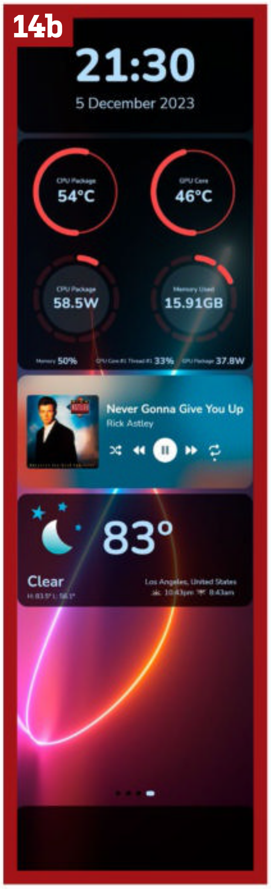
All of this gives it an incredible amount of personality and customization. If you've got a more neutral color scheme, such as the black or white variant, changing out that background and color setup to exactly what you want is just awesome. Plus, having system specs on the fly is just really nice. It's early days, though. We're still hoping that they'll include the ability to change fonts soon, as it has a 'comic sans' vibe to it at the minute **STEP 14B**.

Another unique element to this is that it is effectively still a portrait screen. So when Hyte's program isn't running or its 'Faces' setting deployed, it'll act as a secondary Windows display **STEP 14C**.



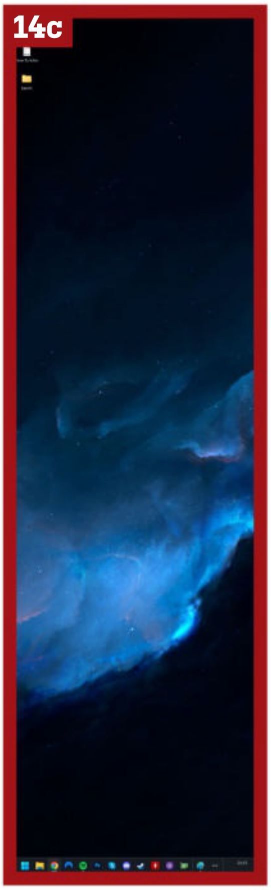
14a

21:11
5 December 2023
Media
Twitch Chat
OBS
Block Game
Shortcut
Calculator
Gallery
Weather
Performance
Screentime
Clock
URL
Emoji Keyboard
Lighting
Notes
Audio Visualizer
IFTTT
Google Calendar
RSS Feeds
Custom Widget
1x1
4x2
4x4
CHORVS
Song of the Void
Pedro Macedo Camacho
+ Add
Media Widget v1.0
28°
Clear



14b

21:30
5 December 2023
CPU Package
54°C
GPU Core
46°C
CPU Package
58.5W
Memory Used
15.91GB
Memory 50%
CPU Core #1 Thread #1 33%
CPU Package 37.8W
Never Gonna Give You Up
Rick Astley
83°
Clear
Los Angeles, United States



14c

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Build or Bust?

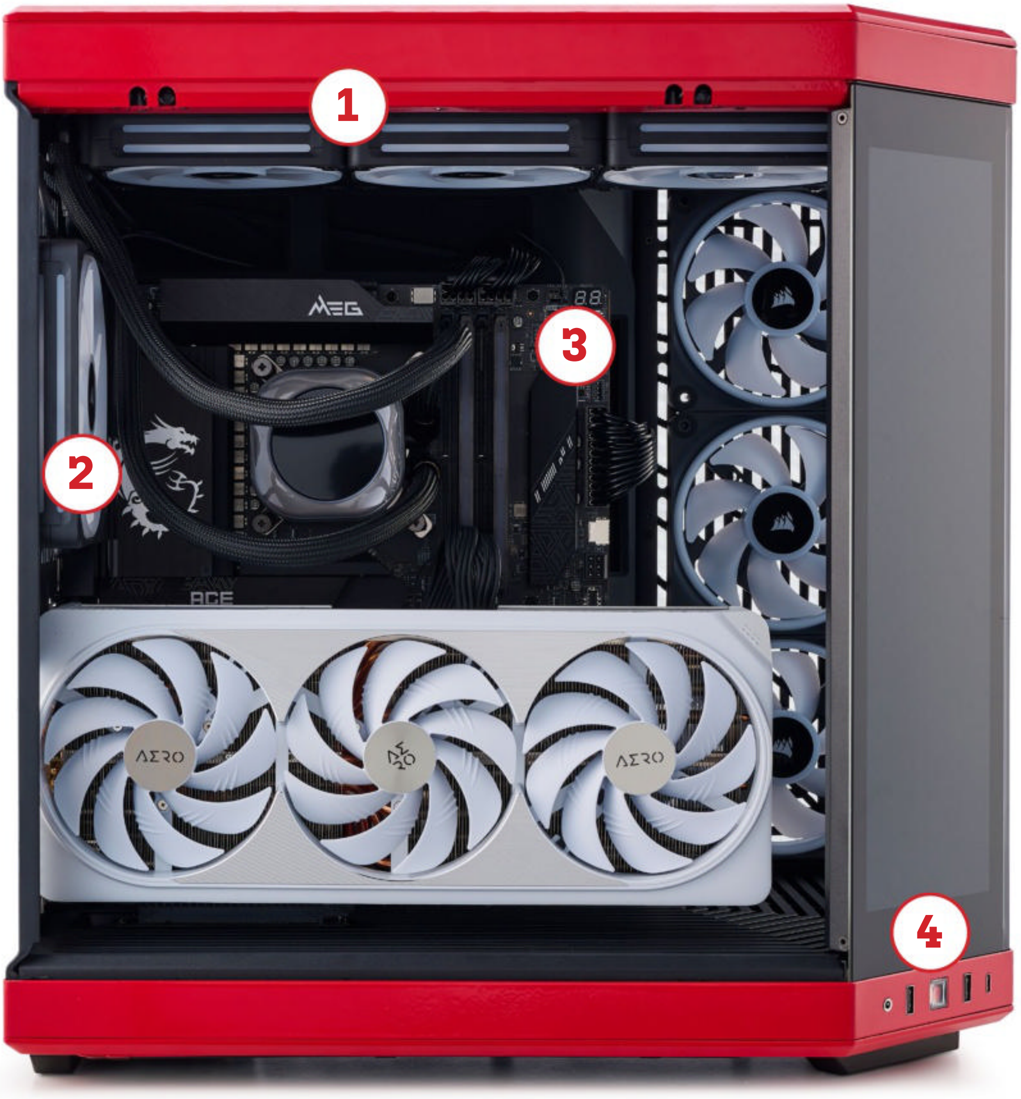
OKAY, SO THAT'S THE BUILD DONE. How is it to use day-to-day? Beautiful, is the answer. We've built a lot of PCs here at *Maximum PC*, but this might just be one of our favorites. Whether it's that crisp display, the stand-out red colorway, the plethora of RGB fans littered everywhere, or all the tiny little thermistors telling us exactly what temp each thing is, it's an incredibly pleasurable thing to look at.

It's not flawless. The case does have its faults, albeit they are rather small: the half-height PCIe slots, and lack of flexibility if you want a traditional GPU mounting solution. The less than obvious way to install three 120mm fans. The rear mounting of 140mm fans (spoilers, it's really not obvious), and the rather ugly PCIe riser do leave us with questions. That said, in almost every other department, it's hard not to love the experience.

Is the touch display a gimmick, though? At the moment we're not sure. It's nothing if not aesthetically pleasing. From a personal standpoint, this editor has used its touch capacity probably three times in a week since having it. Until it gets a bit more support and more program capacity, or some wizz finds a really useful application for it (Android emulator using a Stream Deck mobile app, perhaps), it still feels a bit gimmicky. But again, it's a crisp-looking IPS panel with an impeccable resolution and pixel density.

What about iCUE LINK then? Is it good? Yes. Is it worth the extra money? That's the challenging part. At the moment, a starter set of three 120mm fans will set you back $160. That's a lot of cash, and although the performance is what you'd expect, and the build experience clean (although very different), you could effectively get the same experience building without RGB and grabbing some Noctuas for a lot less.

If you live and breathe RGB, and have the cash to spare, then go for it. But if we're honest, as you can probably see from the benchmarks below, and from the fact that this build costs $30 more than last month's one, despite having a far less powerful CPU and GPU, you might just be better off investing that cash into your core hardware first.



1 Rotating that top mounted radiator so the tubing is going the other way and the cables are connecting to those exhaust fans might give this a much cleaner look.

2 MSI's $700 motherboard is still using that dragon logo on it, and honestly it's starting to look a little dated at this point. That doesn't affect performance, but at this price, it just lacks a little class.

3 A custom white cable kit would look a treat here, and would really make the rest of the build pop.

4 This power button on the bottom right of the chassis? Hyte label it as a 'tactile mechanical switch'—it's terrible. It looks like it's been taken directly from a 1970s vacuum cleaner.

BENCHMARKS

	ZERO-POINT	
Cinebench R23 Single-Core (Index)	2,204	1,909 (-13%)
Cinebench R23 Multi-Core (Index)	36,815	22,221 (-40%)
CrystalDisk QD32 Sequential Read (MB/s)	7,138	7,007 (-2%)
CrystalDisk QD32 Sequential Write (MB/s)	6,299	6,026 (-4%)
3DMark Fire Strike Ultra (Index)	24,114	17,670 (-31%)
Cyberpunk 2077 (fps)	103	69 (-33%)
Cyberpunk 2077 RTX (fps)	69	54 (-21%)
Metro Exodus (fps)	133	87 (-35%)
Metro Exodus RTX (fps)	109	53 (-51%)
Total War: Three Kingdoms (fps)	95	73 (-23%)
Core Price ($)	$3,068	$2,620 (-14.6%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of the 14th gen Gaming PC from our last issue, featuring an Intel Core i9-14900K, Nvidia GeForce RTX 4090, Asus ROG Maximus Z790 Dark Hero Motherboard, 32GB (2x16GB) of Corsair Vengeance DDR5-4800, and 1TB Adata Legend 960 Max PCIe 4.0 M.2 SSD. All games tested at 4K "Ultra" graphics presets with DLSS and V-sync turned off and XMP for RAM speed turned on. No manual CPU overclocking. "Core Price" refers to the key components generating performance (CPU, GPU, Mobo, SSD, RAM), not accessories.

Does Performance Matter?

LONG ANSWER? On the next couple of pages. Short answer? Yes. We've temporarily introduced a new benchmark specifically for this build, mostly to be used as a reference point, and that's the 'core price'. This refers to the core components in each build that generates performance on the desktop. So, CPU, GPU, motherboard (although we did debate removing this, as a good motherboard shouldn't impact performance), SSD, or RAM. You can see the difference between our two systems when looking at their core components is a total of 14.6 percent or about $448. This is actually a really good exercise in comparisons, as if you were to use a similar memory kit here as well, that delta would grow to around $600 or thereabouts. So $2,400 on its core constituent parts, or around 19.5 percent, so bearing that in mind, our price difference is around 15-20 percent (depending on whether you went for pricier memory or not). Yet, on the whole, the average performance drop across all tests was around 25 percent. In game, it was an average performance drop of about 33 percent. That is a staggering drop compared to the price.

Your finances and budgets are a very personal thing, but bizarrely it seems that the more money you spend, the better off you're going to be, certainly if you want to game at 4K. Here's the thing, though. A lot of this is still coming down to the GPU drop rather than the CPU itself. We've got a bit more testing coming up over the next couple of pages, going into detail as to just how much difference that CPU switch makes individually on the same GPU, and whether you can get away with just spending on the GPU instead, but we'll leave that for a little bit.

Ultimately, this is a beautiful system that's been a breeze to put together. It looks incredible, and performs just as well. In isolation, and away from the world of pricing comparisons, all of those figures are solid in-game performance numbers, easily marching over that 60 fps sweet spot that we all like to call home.

Intel Core i9 vs Intel Core i5 – Fight!

WHERE'S THE BEST PLACE TO SPEND YOUR MONEY?

AT LAST, we're at the extended benchmarks we alluded to earlier. So, isolating purely the CPU side of things, does the old adage still hold true? If gaming is your sole and only interest, is a Core i5, 'enough' at 4K?

The answer is yes. We swapped out the Core i5-14600K in our build for the 14900K and run both through an extended suite of gaming benchmarks to see what difference it made at 4K, if any. The answer was, perhaps unsurprisingly minimal.

Most of the time, almost every game was +/- 1-percentage point within one another. Some titles, such as *Total War: Warhammer III*, seemed to prefer the Core i5-14600K's more stable single-core performance (as it didn't come close to its TJMax temp as often as the 14900K), while others with higher-density particle physics, such as *Borderlands 3* and *Metro Exodus*, preferred the 14900K. Again, the difference between the two is so negligible it's barely worth mentioning.

The difference is more tangible at 1080p, that's for certain. Across seven other titles at 1080p, we saw an average frame-rate achieved of around 213 for the Intel Core i5-14600K and 221 for the Intel Core i9-14900K. Again though, although this was a win for the Core i9, it only amounted to an impressive three percent difference between the two. At such high frame rates, it's hardly noticeable in an actual use-case scenario.

The battle of the beasts, which one do you really need?

4K GAMING	INTEL CORE i5-14600K	INTEL CORE i9-14900K
Cyberpunk 2077 (fps)	109	110 (1%)
Cyberpunk 2077 RTX (fps)	69	69 (0%)
Metro Exodus (fps)	133	131 (-2%)
Metro Exodus RTX (fps)	109	111 (2%)
Total War: Three Kingdoms (fps)	95	95 (0%)
Total War: Warhammer III (fps)	79	78 (-1%)
Borderlands 3 (fps)	101	104 (1%)
Horizons Zero Dawn (fps)	116	116 (0%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

All games tested at 4K "Ultra" graphics presets with DLSS and V-sync turned off and XMP for RAM speed turned on. No manual CPU overclocking. Avg fps reported.

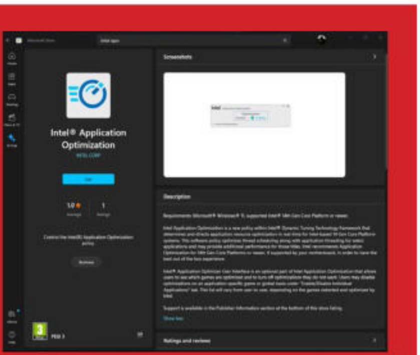
APO THE GAME CHANGER?

Intel's APO could shake things up. Effectively utilizing AI and intelligent resource allocation to improve performance in certain titles, it acts like a graphics driver to improve performance in certain applications and programs for the Intel Core i9-14900K.

There have been several reports of it improving performance by 20-30 percent in the two titles it does support (albeit those two games are *Metro Exodus* and *Rainbow Six Extraction*). However, it's proved challenging to install and run, even for us.

Not only do you need the BIOS firmware to support it, along with DTT drivers installed (dynamic tuning technology), you also need to download it from the Microsoft Store, which can be a challenging and buggy experience. Getting it to work after that has also been greeted with mixed success, with many reporting that it 'fails to connect' on launch.

Simply put, it just needs a little more time in the oven. Whether it makes a renewed appearance for 15th gen remains to be seen. Perhaps by then, we'll see a significant boost in performance for the 14th gen, and a more seamless install process. Right now, it's a swing and a miss.



© INTEL

What should I buy then?

SO THIS IS where things get interesting. Right now, from a purely value perspective, if your intention is to game at 4K and nothing else (a bit of light web-work or otherwise), then an Intel Core i5-14600K makes the most sense. Pair that with an RTX 4090 or 4080, or GPU of your choosing, and you're going to have a good time regardless. At 1080p, there is a difference between the two, but again, as you're already going to be gaming at such high frame rates anyway, it's not going to be noticeable between the two.

The one caveat to this is from the future-proofing standpoint, and with that, we're actually going to make reference to a Terry Pratchett quote, namely Sam Vimes'' 'Boots' theory of socioeconomic unfairness (it's a thing, well worth looking up).

In the short term, right now, the Intel Core i5-14600K is a good pick. It's solid, reliable, performs as well as the 14900K in-game, and is a darn site cheaper than its 24-cored cousin. But (and it's a big but), for exactly how long? As games continue to advance in complexity, and titles get more demanding on resources, at 1080p, 4K and beyond, there could very well be a point in the next three to four years where that humble 14600K isn't looking so hot. At this point, you're inevitably going to have to upgrade and buy a new chip, new motherboard, memory, and more, which will be quite an investment.

On the other hand, if you pick up the 14900K today, and intend to use it for the next six to eight years, you might just be able to eke out a bit more life from the old girl before you need to swap it out for something newer.

Similarly to Sam Vimes' Boots theory, the former could cost more in the long run (at least that's how we're going to justify it to our better halves). The only downside to all this? It's anecdotal evidence leading the fray on this front. After all, we've seen it occur in the past, and things like the Intel Core i5-2500K were still fairly competitive for a good six years before it ultimately had to be retired, although admittedly that was mostly down to a lack of competition from AMD.

Literary great and an economic genius Terry Pratchett's 'Sam Vimes Boots theory of socioeconomic unfairness" actually holds weight here.

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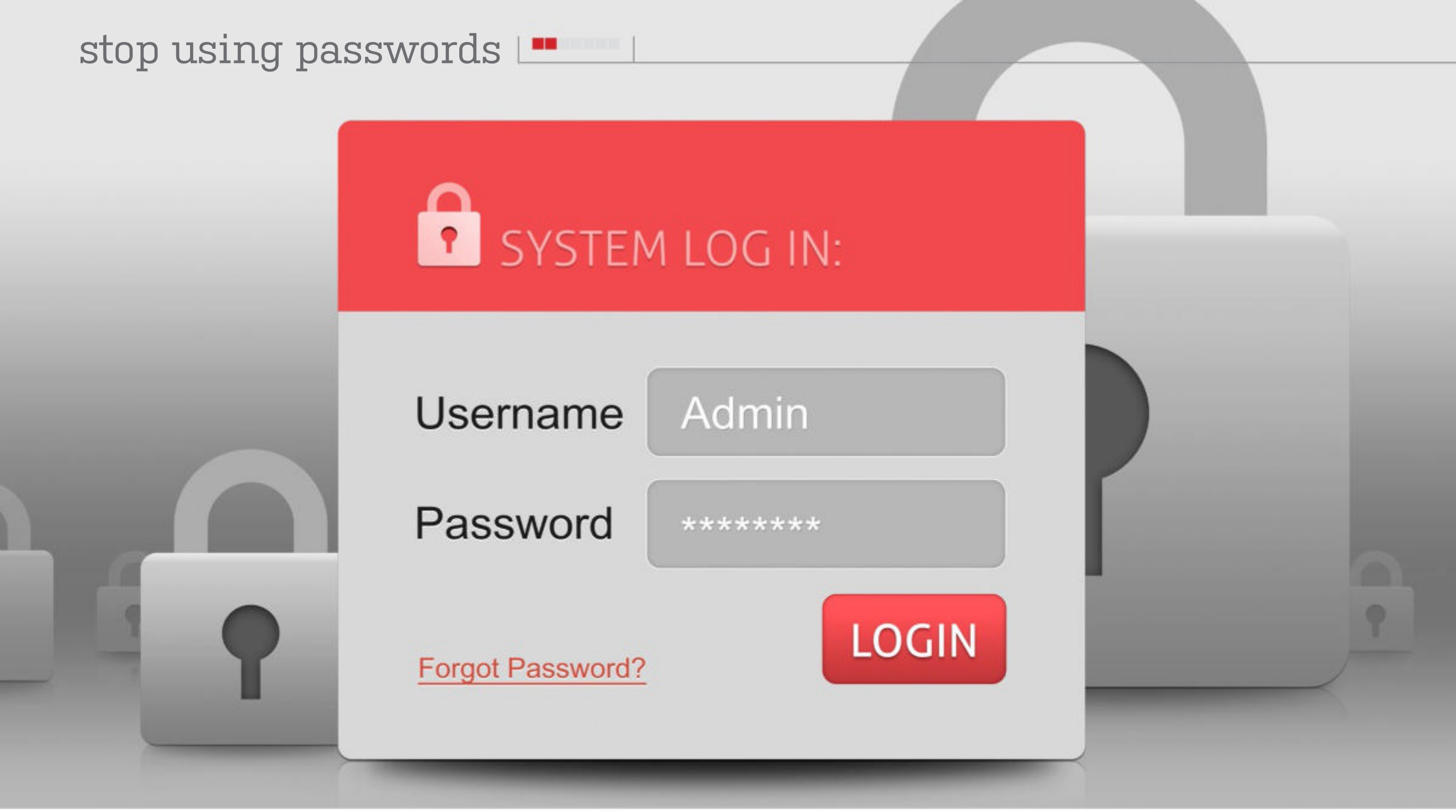
Join the conversation!

Discuss all things PC gaming with fellow readers at our official forums
forums.pcgamer.com

PC GAMER



STOP USING PASSWORDS

Passwords are a hassle to remember and enter, and offer only weak protection for your online accounts. Robert Irvine explains why you should now switch to passkeys

WHETHER YOU store them in your browser, on post-it notes, or in your head, passwords are a necessary evil for protecting your online accounts. The trouble is that they don't perform that job very well, and can prove to be more frustrating than reassuring.

We've all received alarming emails urging us to change our passwords immediately after they've been compromised in a data breach, locked out of accounts when we couldn't remember the password, or had to conjure up convoluted logins containing upper- and lower-case letters, numbers, and special characters.

The introduction of two-factor authentication (2FA) gave our accounts a second layer of security, but because 2FA methods are used in addition to passwords, and usually involve waiting for verification codes to arrive, they make signing into websites even more tiresome.

Thankfully, there is now a reliable solution to the password problem in the form of passkeys. These represent a huge step forward for online security, because they're safer, faster, and more convenient than passwords, with no need to type or remember anything.

As with any new technology, there's still a lot of confusion and uncertainty about passkeys, so in this feature we explain how they work, how to use them, and which websites, apps, and services currently support them.

Once you switch to passkeys, you'll wonder why any of us ever bothered with passwords.

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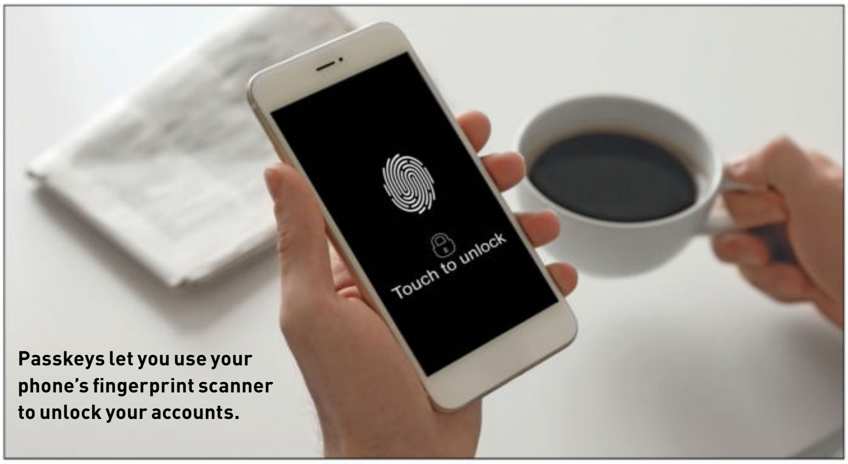
WHY YOU SHOULD DITCH PASSWORDS FOR PASSKEYS



Passkeys let you use your phone's fingerprint scanner to unlock your accounts.

What are passkeys?

Passkey technology is a new means of securing your accounts with websites, apps, and online services without using a password. It shares some similarities with two-factor authentication, which usually requires you to enter a verification code to sign into accounts, but is easier to use, and stops you needing to remember or type any login details.

Instead, passkeys let you log into sites and apps in the same way that you unlock your PC or phone, such as using your fingerprint, face, or a screen-lock PIN. Because this data is stored on your device rather than with the respective service, passkeys are much more secure than passwords, as well as more convenient.

Precisely how are passkeys more secure?

Although traditional passwords are concealed on your screen behind asterisks or bullet points, you still need to type and submit them using plain text. When you create an online account, the website or app encrypts this text and saves the result as a 'hash'. Every time you sign into the site or app, it compares the stored hash with the password you enter, and only grants you access if the two match.

The danger is that if hashes are compromised in a data breach, hackers will be able to decrypt—or 'crack'—them and use the extracted passwords to gain access to users' accounts. Online services should ideally 'salt' their hashes, which means adding random data to passwords before they're encrypted to make them more difficult to crack. But this salting often doesn't happen, and unsalted password hashes that have been stolen in breaches end up being sold on the dark web.

In contrast, passkeys use a type of end-to-end encryption called public key cryptography. Each passkey consists of a pair of keys—a public key and a private key—that are linked to one another. Your public key is stored by the website or app when you create a new account, while your private key remains on your device and is never shared. To sign in, your device sends a request to the site or app, which then returns a challenge that can only be solved with the corresponding private key.

Because passkeys are bound to specific websites and apps, they safeguard you against phishing scams that trick you into entering your login details on fake sites and apps. Only the public key is stored by the online service, but this is useless to a hacker unless they also have your private key. It may sound complicated, but it all happens automatically—and instantly—when you use your passkey method.

What are the main passkey methods?

The most common passkey methods are biometric, such as fingerprint and face scans. You may already use one of these to unlock mobile apps that contain sensitive information, like your banking app.

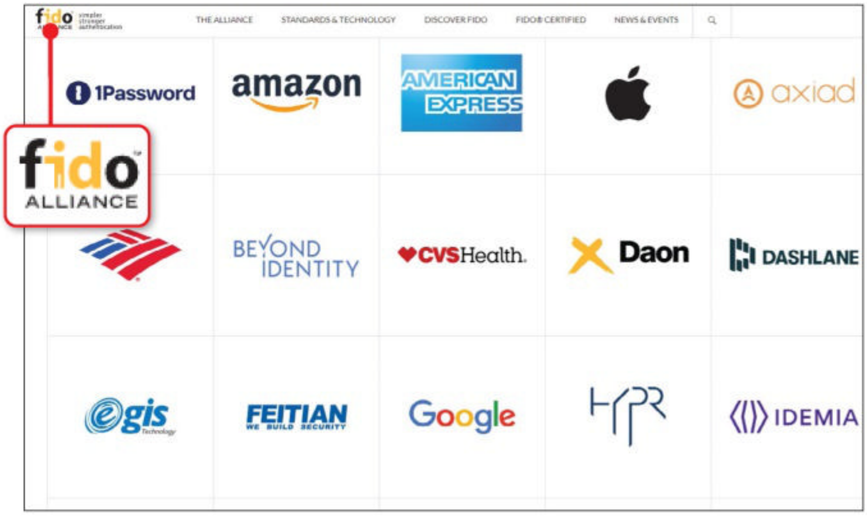
Passkeys work across different devices and operating systems, which means you can sign into websites on your Windows PC from your Android phone or iPhone, either by using your biometric method or screen-lock code or by scanning a QR code. Your account is authenticated over Bluetooth rather than less secure Wi-Fi, which means there's little chance of your data being intercepted by hackers.

Passkeys are also available in physical form on USB security keys such as YubiKeys. We take a closer look on page 39, but please note that not all security keys support passkeys—only those that use the FIDO2 authentication standard.

What is FIDO2?

FIDO stands for Fast Identity Authentication (FIDO2 is the second generation of the technology), and was developed by the FIDO Alliance (fidoalliance.com) to "solve the world's password problem". All passkeys are based on FIDO standards, which allows them to work across your devices, and to be used by any FIDO-certified company.

As we explain over the following pages, members of the FIDO Alliance now include Amazon, Google, Meta, Microsoft, PayPal, and many more—see tinyurl.com/m7z26tx7 for the full list.



Many big tech companies now support passkeys as part of the FIDO Alliance.

© ALAMY, FIDO ALLIANCE

SIGN IN WITH PASSKEYS ON YOUR PHONE & PC

iPhone and iPad

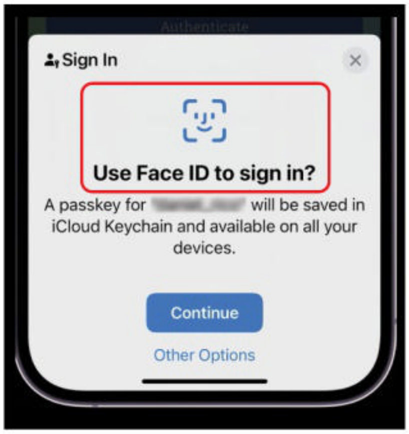
Apple introduced support for passkeys in iOS 16 and iPadOS 16 last year, and refined the feature with the release of iOS 17 and iPadOS 17 in September. They work on all iPhones and iPads that run those operating systems, and are stored in your iCloud Keychain, so you can access your passkeys on all devices you're signed into with your Apple ID.

To use passkeys on your iPhone or iPad, you first need to turn on two-factor authentication. Although passkeys are an alternative to traditional 2FA, they still require you to set up your device as 'trusted'. Open the Settings app, tap your name, and choose 'Sign-In & Security'. Select 'Turn On Two-Factor Authentication', then tap Continue and follow the instructions to add your iPhone or iPad as a trusted device.

You also need to activate iCloud Keychain to sync your passkeys across devices, and ensure you can use them should you lose your iPhone or iPad. Tap your name in the Settings app, select iCloud, then 'Passwords and Keychain' (see screenshot above right), and turn on iCloud Keychain (you may need to sign in with your Apple ID).

You can now create and save passkeys for any websites and apps that support them. As we'll explain later, the steps vary between services, but you should find the option to set up a passkey in your account settings. This will use your default method for unlocking your iPhone or iPad, such as Touch ID, Face ID (see screenshot below), or a passcode, so you can sign into the site or app without entering your password. Simply tap the username field on the sign-in screen, and use your passkey method to confirm your identity. All the passkeys you create are stored in the Passwords section of your iOS device's Settings app.

To use your saved passkeys to sign in on a device that isn't associated with your Apple ID, such as a Windows PC, enter your username on the sign-in screen and select 'Other options', 'Passkey from nearby device', or similar. Follow the on-screen instructions to display a QR code, and scan it with the camera on your iPhone or iPad. The passkey saved in your iCloud Keychain will complete the login process. You can create passkeys on non-Apple devices in the same way.

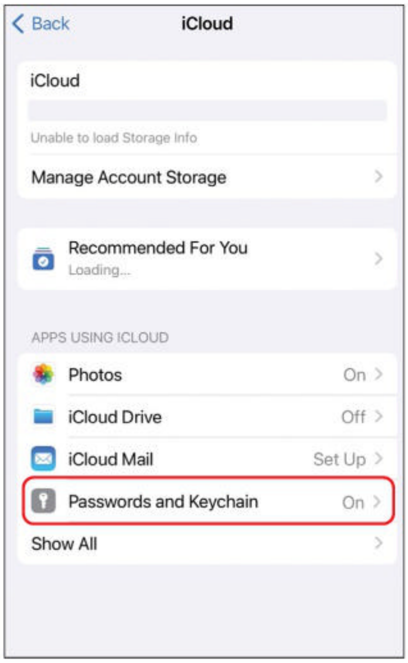


Sign In

Use Face ID to sign in?

A passkey for [redacted] will be saved in iCloud Keychain and available on all your devices.

Passkeys let you use Touch ID or Face ID to sign into accounts



iCloud

Unable to load Storage Info

Manage Account Storage

Recommended For You
Loading...

APPS USING ICLOUD

Photos: On

iCloud Drive: Off

iCloud Mail: Set Up

Passwords and Keychain: On

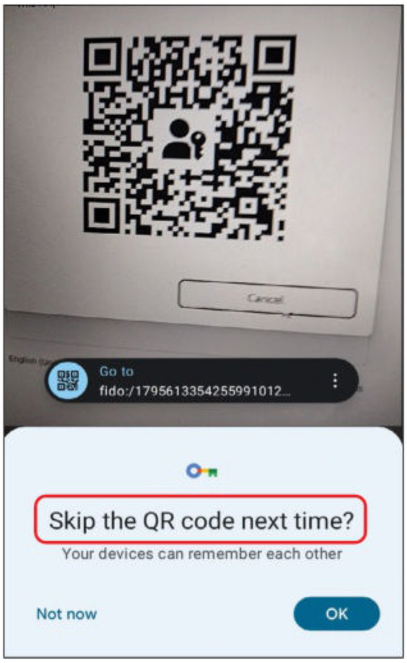
Show All

Turn on iCloud Keychain to use passkeys on your iPhone or iPad.

Android phone and tablet

Android 14, which began rolling out on October 14, brings improved support for passkeys by allowing more apps, such as third-party password managers, to create and store them. But as with previous versions of the mobile operating system, it will be several months before most Android users receive the update, but newer phones such as the Samsung Galaxy S23 line have also recently received the update.

In the meantime, you can access passkeys on your Android phone or tablet through Chrome, and also use them to sign into your Google account(s) (provided you have screen lock enabled on your device).

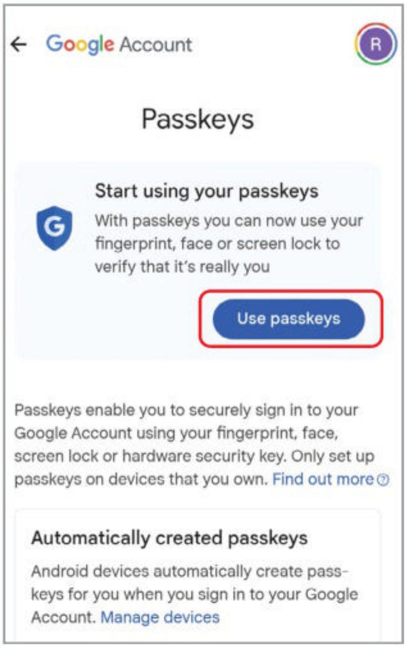


Go to
fido:/1795613354255991012...

Skip the QR code next time?

Your devices can remember each other

Skip the QR code to apply passkeys automatically from your Android phone.



Passkeys

Start using your passkeys

With passkeys you can now use your fingerprint, face or screen lock to verify that it's really you

Passkeys enable you to securely sign in to your Google Account using your fingerprint, face, screen lock or hardware security key. Only set up passkeys on devices that you own. Find out more

Automatically created passkeys

Android devices automatically create passkeys for you when you sign in to your Google Account. Manage devices

You can now use passkeys to sign into your Google account on any device.

When you visit a passkey-supporting website in Chrome and enter your username or email address, you'll see the option to 'Create a passkey'. Tap this, then use your preferred screen-lock method—Fingerprint, Face Unlock, PIN or Pattern—to secure your account.

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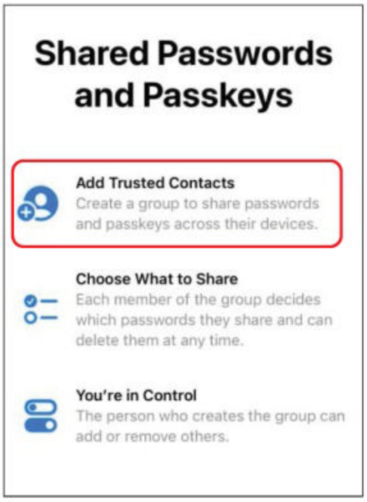
Share your passkeys with other people

Apple offers the useful ability to securely share your passkeys with other people. This allows you to grant trusted friends and family members access to your accounts with specific websites and apps, without needing to send them the password.

The sharing is performed using AirDrop, so both you and the recipient must have that feature enabled on your iPhone or iPad. Open the Control Center by swiping up from the bottom edge (on an iPhone) or down from the top-right corner (on an iPad) of the screen and ensure AirDrop is activated, along with Wi-Fi and Bluetooth (which it uses to transfer data). Additionally, the person you're sharing your passkey with must be listed in your Contacts with the email address they use for iCloud, and vice versa.

To send the passkey, open the Settings app, tap Passwords, and choose the account you want to share. Press the Share button and select the device or name of the person you want to send the passkey to. When they receive your AirDrop request, they can tap Accept to use the passkey to sign into the relevant account.

You can also create a group of trusted contacts to share specific passkeys between your iOS devices (see screenshot). Passkey-sharing isn't yet available in Android or Windows, but it's possible it could be added in the future, and some password managers now offer the feature.



Shared Passwords and Passkeys

Add Trusted Contacts
Create a group to share passwords and passkeys across their devices.

Choose What to Share
Each member of the group decides which passwords they share and can delete them at any time.

You're in Control
The person who creates the group can add or remove others.

Passkeys are automatically saved to Google Password Manager in Chrome and synced across other devices on which you're signed into the browser. This enables you to use your phone or tablet to log into sites on your desktop PC by scanning a QR code with your camera. Choose to skip the QR code next time (see screenshot above left), and you'll be able to apply your passkey simply by tapping a notification.

You should see the option to 'Simplify your sign-in' with a passkey when you next log into your Google account. If not, go to tinyurl.com/6f9ahff3 in any browser (desktop or mobile), select 'Get passkeys', and sign into your Google account. Choose 'Continue', confirm your passkey security method, and select 'Use passkeys' (see screenshot left). You can now sign into your Google account without a password—a 'Skip password when possible' option will be turned on in your account settings.

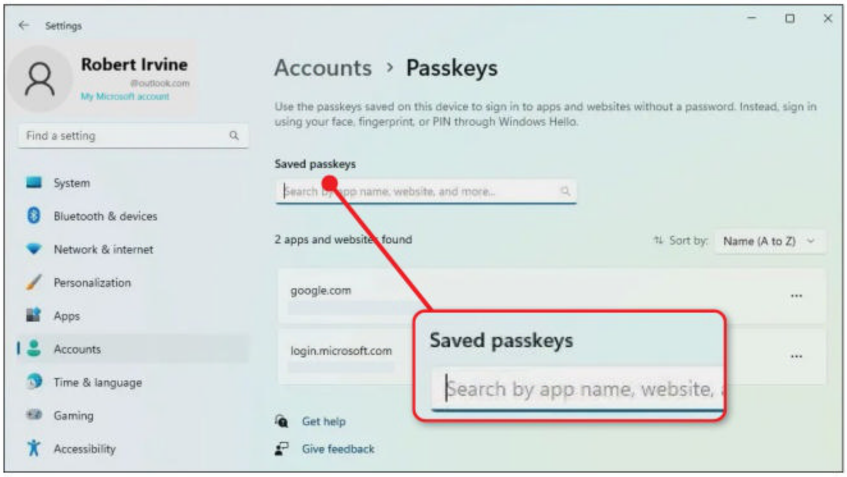
Windows PC and laptop

Microsoft officially added passkeys to Windows 11 with the release of the Moment 4 update in September. You'll find the new option by opening the Settings app, selecting Accounts, then scrolling down to 'Passkeys settings' at the bottom of the 'Account settings' section.

However, Windows 10 users need not feel left out, because the passkeys feature is effectively an extension of Windows Hello, which offers password-free sign-in on both operating systems using your fingerprint, face, a PIN, or a physical security key. The big difference is that Windows 11 lets you create and autofill passkeys for supported websites and apps (see screenshot above right), so they can be applied with a single click, while Windows Hello in Windows 10 is primarily used to sign into your PC and Microsoft account.

When you register with or sign into a site, or open an app that supports passkeys, Windows 11 will give you the option to save a passkey using your default Hello method—remember that you'll need a fingerprint reader or compatible webcam (see tinyurl.com/5fjprtew) to sign with your finger or face. You can also select 'Use another device' to save the passkey to your iPhone or iPad by scanning a QR code, or to a linked Android phone or tablet. Choose 'Sign in with a passkey' to access the site or app.

In Windows 10, you can still sign into websites with passkeys using the options provided by your mobile device, but you won't be able to manage them on your PC through Windows Hello. You can, however, store passkeys on a USB security key—see page 33 for the best options.



Use the passkeys saved on this device to sign in to apps and websites without a password. Instead, sign in using your face, fingerprint, or PIN through Windows Hello.

Windows 11 has a new passkeys manager for saving password-free logins.

Quickly test how passkeys work

Over the next few pages, we'll reveal which programs, apps, and websites support passkeys. For a demonstration of how they work, visit Passkeys.io (www.passkeys.io). If you're using Chrome, you can save the passkey to Google Password Manager, so you can autofill it by clicking the email-input field. In other browsers, click 'Sign in with a passkey' and choose another option, such as using your phone, Windows Hello, or a security key.

GET READY TO BECOME A TRUE PYTHON EXPERT

Make Python work for you with tutorials on coding with Django, Flask, Pygame and even more useful third-party frameworks.

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Everything you need to start coding with Python in Linux
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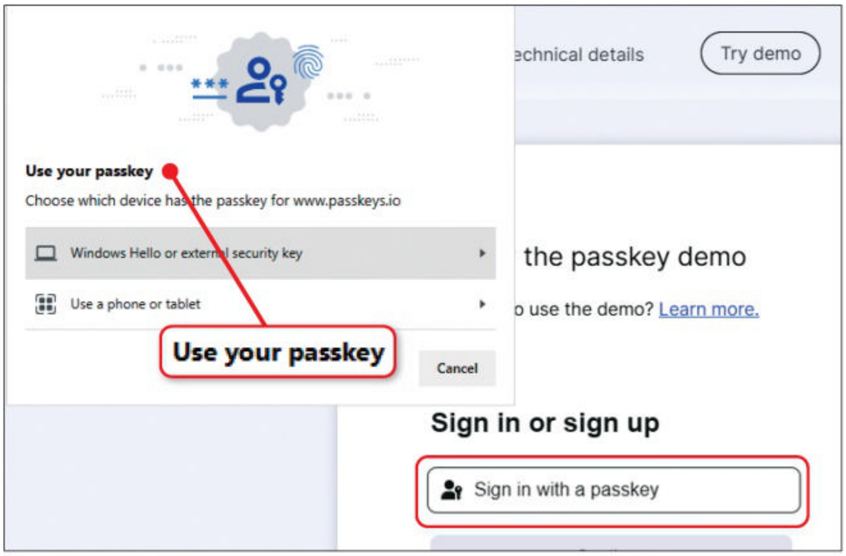
SOFTWARE & SERVICES THAT SUPPORT PASSKEYS

Web browsers

As we explained earlier, Chrome now lets you use passkeys in both its desktop version and mobile app, and it's likely that other browsers will follow suit. Edge also offers the feature—when you visit a site that supports passkeys, click the 'Sign in with a passkey' option (see screenshot right), or similar, and choose to sign in with your phone, Windows Hello, or a security key.

If you're using Windows 11, you can save your passkeys in Windows Hello and autofill them on websites. The option to 'Autofill passwords and passkeys' directly in Edge was recently spotted in the developer build of the browser (see tinyurl.com/255sv5wp), so should be coming to the stable version soon (hopefully for both Windows 10 and 11).

Firefox doesn't yet fully support passkeys, but it does let you sign into websites using USB security keys. You'll see that option when you try to use a passkey on a supported site. As Brave and Vivaldi are based on the same Chromium code as Chrome and Edge, they also let you use passkeys from your phone, Windows Hello or a security key.



Use your passkey

Choose which device has the passkey for www.passkeys.io

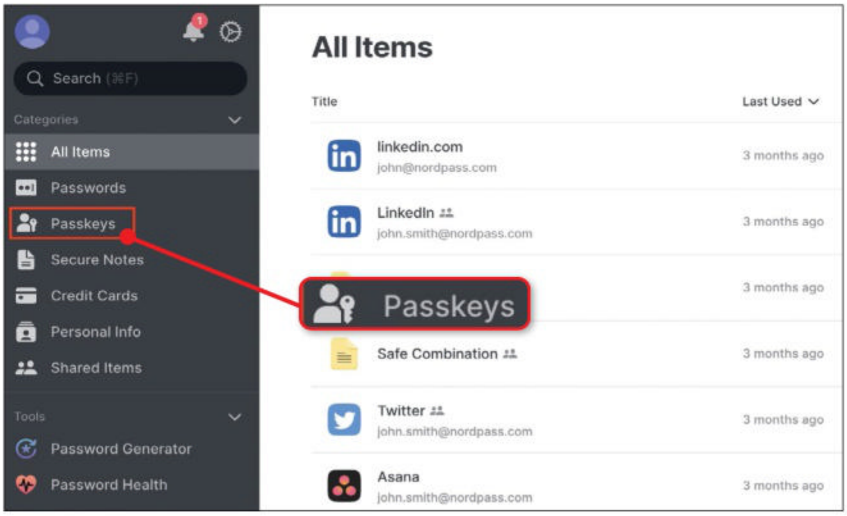
echnical details
Try demo
Windows Hello or external security key
Use a phone or tablet
Use your passkey
Cancel
the passkey demo
o use the demo? Learn more.
Sign in or sign up
Sign in with a passkey

Edge lets you sign into sites using passkeys—and will soon autofill.

Password managers

Because passkeys are intended to replace passwords, some of the most popular password managers have adopted an 'if you can't beat them, join them' approach.

NordPass Password Manager, from the company behind NordVPN, was one of the first tools to add support for passkeys, back in March (nordpass.com/passkeys). This lets you easily create, sync, and manage password-free logins across all your devices and operating systems through the NordPass web vault, desktop app (see screenshot below), Chrome and Firefox extensions, and iOS app—passkeys are also available in the Android app, but only in Android 14. Passkeys are included in the free version of NordPass, but if you want to share them with other people, you need a paid subscription, which costs from $1.24 a month.



Search (⌘F)
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Passkeys
Secure Notes
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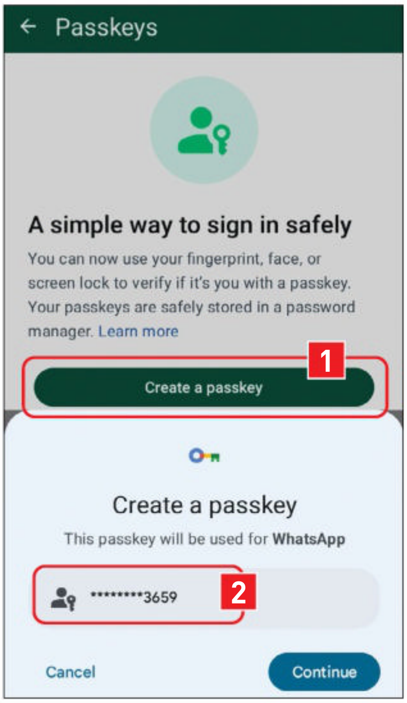
Password Generator
Password Health
All Items
Title
Last Used
linkedin.com
john@nordpass.com
3 months ago
LinkedIn
john.smith@nordpass.com
3 months ago
Passkeys
3 months ago
Safe Combination
3 months ago
Twitter
john.smith@nordpass.com
3 months ago
Asana
john.smith@nordpass.com
3 months ago

The free version of NordPass lets you manage passkeys as well as passwords.

Rival password manager Dashlane integrated passkeys even earlier, and even lets you log into your account using a biometric method or code (tinyurl.com/49c7hr45), rather than a traditional 'master password'. However, it recently changed its free plan to limit you to 25 logins—to store unlimited passwords and passkeys, you need to upgrade to Premium for $2.49 a month.

1Password, which costs $2.99 a month after a 14-day free trial, introduced support for passkeys in September (tinyurl.com/m23ayk4w). The service usefully highlights saved logins you can convert to passkeys, and



A simple way to sign in safely

You can now use your fingerprint, face, or screen lock to verify if it's you with a passkey. Your passkeys are safely stored in a password manager. Learn more

Create a passkey

This passkey will be used for WhatsApp

Passkeys
1
Create a passkey
2
*********3659
Cancel
Continue

WhatsApp now lets you sign into its Android app using a passkey.

© EDGE, WHATSAPP, NORDPASS

provides a regularly updated directory of passkey-compatible services (http://passkeys.directory).

Other password managers planning to add passkey support by the end of the year include *Maximum PC* favorite Bitwarden (tinyurl.com/26aat4pj) and LastPass (tinyurl.com/5n7h5muj).

Messaging and social apps

Perhaps the most exciting recent addition to passkey-supporting services is WhatsApp, albeit only in the Android version at the moment (see announcement at tinyurl.com/bdd5fx9x). The Messaging app already lets you lock your chats using your fingerprint by going into Settings and choosing Privacy, then Fingerprint Lock. However, the new option provides more ways to sign in securely.

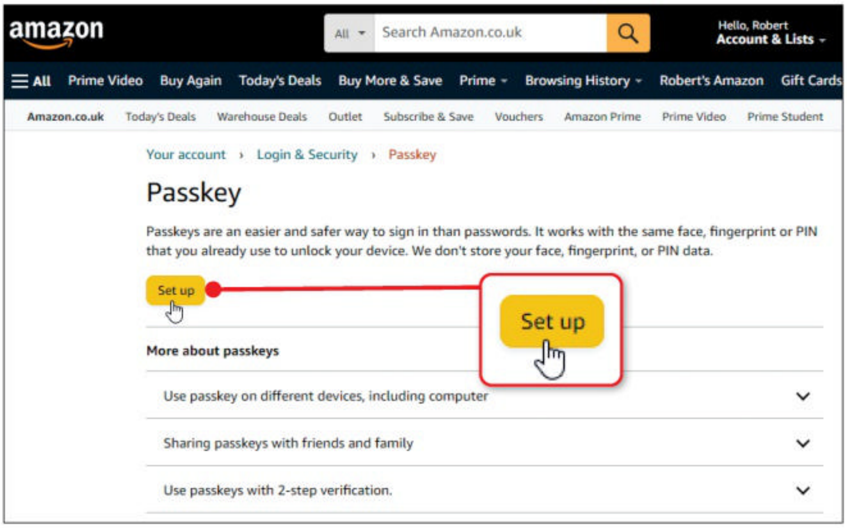
Tap your profile picture in WhatsApp and select Account, then Passkeys (if you can't see this, the update hasn't rolled out to your Android phone yet). Press 'Create a passkey' (1 in our screenshot above), and WhatsApp will assign the passkey to your phone number 2 and save it to your Google account. Tap 'Continue' and use your preferred screen-lock method (fingerprint, face, or PIN) to create the passkey. Choose 'Revoke' to delete it and stick with your previous sign-in method.

Surprisingly, considering that WhatsApp's owner Meta is a board-level member of the FIDO Alliance (see page 33), passkey support has yet to be added to Meta's other apps, such as Facebook and Instagram. However, you can protect your Facebook account with a security key that lets you log in without a password on your PC, phone, or tablet—see tinyurl.com/yeyj735u for details.

The only other major social-media app you can sign into with a passkey is TikTok for iOS, though the feature will soon be coming to LinkedIn and X (formerly Twitter)—see tinyurl.com/332w8pws.

Online stores and services

Traditional passwords have always been a weak way to protect your accounts with online stores. Once a hacker gets hold of your password, they can instantly access your personal and payment information, and make purchases in your name. So we're pleased that some of the biggest web retailers have implemented passkeys as a much stronger and less fiddly security measure than 2FA.



Passkey

Passkeys are an easier and safer way to sign in than passwords. It works with the same face, fingerprint or PIN that you already use to unlock your device. We don't store your face, fingerprint, or PIN data.

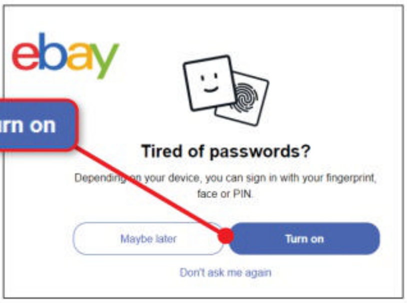
More about passkeys

Use passkey on different devices, including computer

Sharing passkeys with friends and family

Use passkeys with 2-step verification.

Create a passkey to sign into your Amazon account without a password.



Tired of passwords?

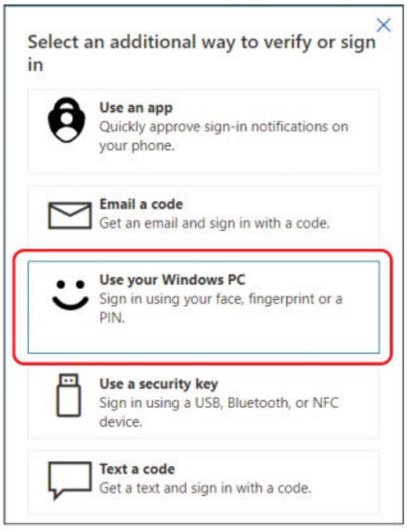
Depending on your device, you can sign in with your fingerprint, face or PIN.

eBay is prompting users to turn on passkeys for their accounts.

In October, Amazon quietly introduced passkey support on its website—but not in its Android or iOS apps. To activate the feature, go to the Your Account page (tinyurl.com/bdds7k9p), click 'Login & Security', and sign into your account (with your usual password). Click the 'Set up' button next to the new Passkey option, then 'Set up' again (see screenshot above right), and choose your passkey device—phone, tablet, Windows Hello, or security key.

You'll receive a notification to apply the passkey method you want to secure your Amazon account with. This will create and save your passkey, so you can sign into Amazon without a password. Note that if you already have '2-step verification' set up, you'll need to enter a code after using your passkey. This rather defeats the object, and has led one passkey expert to criticize Amazon's "poor implementation" (tinyurl.com/mrxyju55).

Passkeys are also available for eBay—you may be prompted to turn on the option when you next sign in (see screenshot below left). If not, go into your eBay account settings (tinyurl.com/3nu3hk84), and click 'Sign-in and security'. Click 'Turn on' next to Passkeys, and follow the instructions to set up your passkey. If you don't see the Passkeys option, choose 'Turn on' next to 'Face/fingerprint/PIN sign in' or 'Security key sign in', depending on your preference. As with Amazon, passkeys are currently only available on the eBay website, not in its mobile app.



Select an additional way to verify or sign in

Use an app
Quickly approve sign-in notifications on your phone.

Email a code
Get an email and sign in with a code.

Use your Windows PC
Sign in using your face, fingerprint or a PIN.

Use a security key
Sign in using a USB, Bluetooth, or NFC device.

Text a code
Get a text and sign in with a code.

You can sign into your online Microsoft account using a passkey.

The opposite is true of Uber, which now lets you order everything from taxis and train tickets to takeaways and groceries. This only supports passkeys in its mobile app (tinyurl.com/yjwv7nwa)—tap Account, then 'Manage Uber account', and press the Security tab. Select 'Passkeys' then 'Create a passkey' to use your face, finger, or PIN to log into Uber.

Similarly, you can use passkeys to access your PayPal account, but only in Chrome for Android or Safari for iOS—not your desktop browser. When you sign into PayPal in either mobile browser, you should see the option to 'Create a passkey'—see tinyurl.com/yckekwfk for more information.

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Other tech companies

Many big tech companies have already embraced passkeys, and many others are FIDO Alliance members, so are likely to introduce the feature soon.

We've already mentioned that Microsoft has added a passkey manager to Windows 11, and it also lets you use a passkey to access its online tools, such as Outlook, OneDrive, and Microsoft 365 apps.

To create your passkey, go to the Security section of your account (tinyurl.com/47k6mj87) and click 'Add a new way to sign in or verify'. Select 'Use your Windows PC' or 'Use a security key' and follow the instructions. When you visit Microsoft's 'Sign in' page (tinyurl.com/yck3wh53), click the 'Sign-in options' button and choose to sign in with Windows Hello or a security key.

Adobe added passkey support for online accounts earlier this year—go to tinyurl.com/bdpn87c4 and click Add next to Passkeys to set this up. Readers in the UK who use Virgin Media can now sign into their accounts with their face or fingerprint, though the company calls the feature Device Authentication rather than Passkeys (see tinyurl.com/559kx7cf).

Other participating tech companies include Nvidia (click 'Login with Security Device' at tinyurl.com/2p9k47rf), online office suite Zoho (see tinyurl.com/3n73f594) and Yahoo (tinyurl.com/ycyj2mjf), though its passkeys aren't yet available to all users.

SIGN IN WITH A USB SECURITY KEY

We've mentioned USB security keys throughout this feature, so you may be wondering which one you should buy. We recommend using a key and another passkey method, so you will still be able to access your accounts if you lose your device.

As long as the key is FIDO-certified, it will work with all websites and apps that support passkeys, as well as those that only support security keys (such as Facebook), but there are significant differences between the devices. Here's our pick of the bunch.

When will passkeys replace passwords?

Passkeys are undoubtedly the future of logins, and hopefully this feature will have convinced you to try them. However, we still have some way to go before passwords become obsolete, and many tech companies—even members of the FIDO Alliance—are yet to introduce full passkey support.

Google's recent switch to passkeys is a major step towards mainstream adoption, as is Microsoft's new passkey manager in Windows 11, but it's likely that we'll continue to hang on to traditional passwords for another few years.

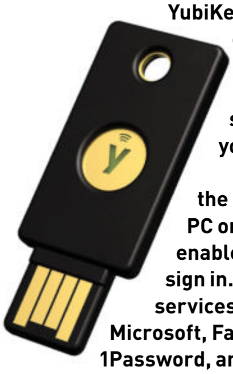
Early data suggests that people find it easy to switch to passkeys. Research by Dashlane found that 92 per cent of passkey-creation requests are completed successfully, compared with 54 per cent of password-creation requests (tinyurl.com/9tpz52hu).

The simplicity, security, and convenience of passkeys give them a strong chance of succeeding. Ultimately, it depends on website and software developers making the transition as easy as possible, and promoting passkeys as the best alternative to passwords.

BEST ALL-ROUND KEY

YubiKey 5 NFC

$50 from yubico.com



Made by Yubico, the co-developer of the FIDO authentication standard, the tiny YubiKey 5 NFC (below) fits comfortably on your keyring, so you can access your accounts securely wherever you go.

Simply plug it into the USB-A port on a PC or tap it on an NFC-enabled phone or tablet to sign in. It's compatible with services including Google, Microsoft, Facebook, Dropbox, 1Password, and many more, and is waterproof and crush-resistant. A USB-C version—the YubiKey 5C NFC—is available for $55, and Yubico has lots of other keys in its range (see yubico.com/products).

BEST BUDGET KEY

Thetis Fido U2F Security Key

$29 from thetis.io

This impressively cheap security key (right) has a compact folding design with a rotating aluminum casing that protects its connector against drops, bumps, and scratches. It supports FIDO's U2F (Universal 2nd Factor) standard rather than the older UAF (Universal Authentication Framework) and OTP (One Time Passcode) protocols, but still works with a wide variety of services. This model is Bluetooth-enabled, but others in the range aren't, so ensure you buy the right one if you want to sign into accounts wirelessly.

BEST BIOMETRIC KEY

Kensington VeriMark

$75 from store.kensington.com

Although it lacks NFC, which means you need to connect it to a phone or tablet with a USB cable, the Kensington VeriMark Guard (below) has the advantage over other security keys of a built-in fingerprint reader. This gives you two ways to sign into accounts on your PC, and ensures that nobody but you can access your data.

Its tiny design (7x18x21mm) means the key is best left plugged into your computer, though it does come with a protective cover and tether.

1
2
ONLYKEY
4
3
crp.to
6
5

BEST PASSWORD MANAGER

CryptoTrust OnlyKey

$99 from onlykey.io

The OnlyKey (left)combines a security key with a password manager, complete with a built-in keypad for typing logins without them being stolen by keyloggers.

It supports several methods of authentication, including U2F and OTP, and is itself protected with a PIN so nobody can access your accounts if it's lost or stolen.

Extra features include encrypted backup and self-destruct (which wipes the device after 10 failed attempts to unlock it). However, its user interface is rather confusing.

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WINDOWS 10

STICK, UPGRADE OR SWITCH?

Don't panic

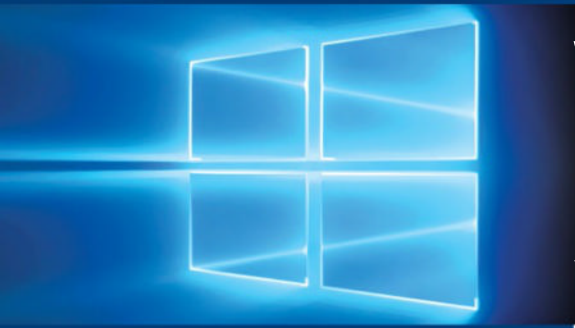
THOSE WERE THE WORDS so famously written across the Hitchhiker's Guide to the Galaxy in Douglas Adams' eponymous book, and they apply equally well here. Windows 10 has already stopped getting new features, and security updates will come to a halt in October 2025. The clock is ticking.

While you shouldn't panic, you should think about what happens next before your hand is forced. Follow Microsoft's advice to the letter, and that perfectly functional PC or laptop will be consigned to landfill as security updates end. Lee, opposite, is not happy about that.

Perhaps you want to wait it out. Maybe Microsoft will bow to the pressure and keep releasing security updates? Or you could simply ignore Davey Winder's advice on p47 and keep running Windows 10 anyway.

We don't think that's a great idea. If you can upgrade to Windows 11—and by now you'll have been nagged many times by your installation—then we recommend doing so. If not, then you do have options. We explore what Linux Mint and Tiny11 have to offer on p44 and p45 respectively. There's also the streaming option—Jon Honeyball delivers his verdict on that on p46.

There's a lot to think about, no matter what kind of Windows user you are. What if you're a gamer who wants the best stability? Someone with a parent who isn't able to perform their own upgrade? Or a small business owner who still has a few older PCs going in its fleet? Read on to find out your best options...



With hundreds of millions of computers still stuck on Windows 10, due to go end of life in 2025, we investigate your options

Don't landfill that old PC

Lee Grant is not overly impressed by Microsoft failing to provide an upgrade path

THERE'S ALWAYS a better option than automatically shoving an old PC into landfill. First, let's look at the machine. A ten-year-old desktop PC may include a 4th gen Core i7, with 16GB of RAM and decent graphics. Even today, something like that will perform for everyday needs. It may need a cheap SSD upgrade to give it some pep, but that goes for 99 percent of machines with spinny drives.

If the machine is a decade-old Athlon 2, then running Windows 10 is probably hard work. However, adding copious amounts of RAM to an old machine is incredibly cheap, and switching from 4GB to 16GB will help even the slowest CPUs.

Fundamentally, this is a software issue. Windows 10 is much more sluggish than previous versions of the OS, so ditching Microsoft for a good, user-friendly software option—Ubuntu, Mint, ChromeOS Flex—breathes new life into old kit and keeps them out of landfill. As we move towards a browser-based existence, a quick OS and an up-to-date browser will satisfy the needs of many users.

Landfill should always be the last option. There will be parts inside a ten-year-old PC that others can make use of. The whole machine may be useful to someone who isn't unalterably besotted with Windows, and is willing to explore alternatives that other platforms can offer.

If you decide that the machine no longer fits your needs, then give someone else a chance to use it. There are organizations all over the country who take in machines, refit them, and give them to people stuck in digital poverty. Via these organizations, the machines can also be sent to places where some genuine recycling will take place—and perhaps some rare-earth element extraction. In the US, landfill use is on the decline and most things now are exported or crushed and burned. The uncomfortable reality of sustainability is that we all need to buy less stuff, so keeping something in use is part of that deal.

Microsoft, by killing Windows 10 without an upgrade path for old hardware, is condemning millions of machines to a crusher. It can wave its green credentials all it likes—this is on its shoulders.

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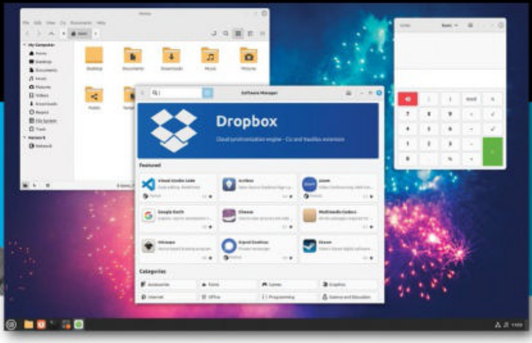
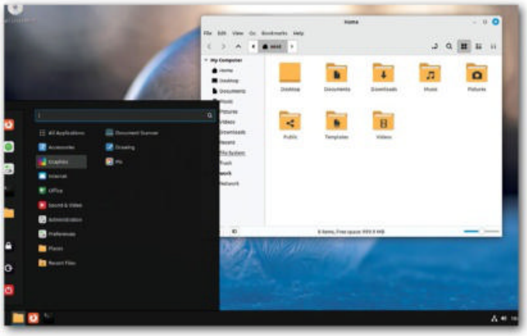
Linux Mint

Nik Rawlinson is already a Linux convert. Here, he offers a few good reasons to switch





TOP **Linux Mint comes with most of the tools you need pre-installed. ABOVE Linux Mint's menu and taskbar will be familiar to Windows switchers.**

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Linux was once the standard—but never entirely helpful—answer when asked what to do with an old computer. For many, it was something you tinkered with when you'd moved to a new machine and could afford to corrupt your old workhorse. There was no guarantee that a Linux machine would play nicely with your existing data, sharing files with friends could be difficult, and the overall process could often have often been a lot more user friendly. None of that is true today.

A FAMILIAR ENVIRONMENT

Let's be blunt: there's no reason why Linux shouldn't be your primary operating system. Most of your data is platform agnostic, many apps run in the browser, and Linux is as easy to use as Windows.

Ubuntu might be the best-known distribution, but Linux Mint (linuxmint.com), which is based on Ubuntu, is where many Windows switchers end up. Where Ubuntu uses the Gnome desktop environment, Mint uses Cinnamon by default, but can work with MATE or Xfce. Cinnamon retains many Windows constructs that Gnome lacks, including the taskbar, applets, and desklets (like Windows' desktop gadgets).

I also recommend Zorin OS (zorin.com), particularly if you'd be happy to pay $39 for the Pro edition. This includes one of the best Windows 11 desktop themes you're ever likely to come across.

LONG-TERM SUPPORT

Linux may only command around three percent of the market for desktop operating systems, but the community that uses it is active and supportive. You'll have no trouble finding help, nor in keeping your system secure. Linux checks for patches and downloads them, just like Windows Update. The latest release of Linux Mint, version 21.1, Victoria, is based on Ubuntu 22.04 LTS, so will receive support until April 2027. That makes it great for long-term deployments.

A FRIENDLY INTERFACE

Using Linux once required familiarity with the command prompt, but that's rarely the case today. You can install software without touching the keyboard, thanks to built-in app stores, and Setting applets make configuration easy to accomplish.

Nor do you need to relearn your Windows muscle memory. Keyboard shortcuts carry across, so you already know 90 percent of what you need to get started.

ACCESS TO YOUR DATA

Mint comes bundled with LibreOffice, which offers broad compatibility with Microsoft's Office document formats. Linux distributions don't have access to the Calibri or Cambria fonts used in Office, but alternatives are available. Carlito (tinyurl.com/2kubdj8jo) and Caladea (tinyurl.com/2nmntde4a) were designed to be metrically equivalent to Calibri and Cambria, and Microsoft has made other fonts available using Terminal. On a Debian operating system like Linux Mint, the command is:

```
sudo apt install ttf-mscorefonts-
installer
```

The package includes Arial, Times New Roman, Georgia, Impact, and Verdana.

SAVE MONEY... AND THE PLANET

Linux Mint requires 2GB of RAM, 20GB of disk space and a 1,024 x 768 display. Compare that to Windows 11, which needs double the RAM, 64GB storage, an HD (720p) display, and Trusted Platform Module version 2 (TPM 2). To keep older hardware running without compromising security, Linux is your best bet.

CARRY ON RUNNING (SOME) WINDOWS APPS

Switching to Linux doesn't mean losing access to apps you rely on. Mainstream Windows apps such as Inkscape, DaVinci Resolve, and Thunderbird have Linux equivalents, others run in a browser, and many older programs can be run using WINE (winehq.org). WINE is a Linux environment that acts as a Windows layer on top of the Linux OS. It isn't installed by default, but you can set it up through the Terminal.

WINE supports 30,000 Windows apps, including Photoshop CS6 and Excel 2016. When browsing the list (appdb.winehq.org), favor apps with Platinum or Gold ratings, as these are considered to work without issue. You'll need your old installation media to set them up.

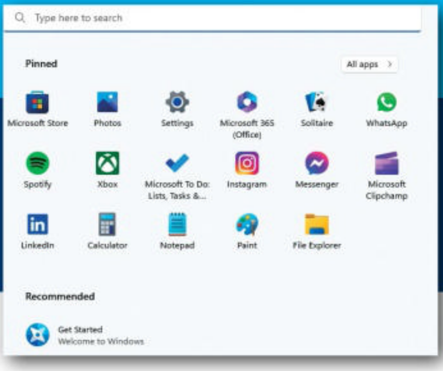
WHY NOT LINUX MINT?

I've presented the case for Linux Mint, but why not run Ubuntu instead? You'll receive updates sooner, and there will be fewer links in the dev chain, as your OS won't be an adaptation of an existing OS.

You will notice that I only say "some" Windows apps work. If you need to run specific versions, there's often no option but to stick with Windows or switch to macOS, where equivalent versions exist. In this case, if your hardware doesn't have the specs required by Windows 11, check out Tiny11.

Tiny11

We asked **Nik Rawlinson** to move out of his comfort zone and give this stripped-down version of Windows 11 a try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Get Started
Welcome to Windows

Tiny11 is a stripped-down version of Windows 11. Where the full-fat OS requires 4GB of RAM and 64GB of drive space, Tiny11 can manage with 2GB and 8GB respectively. It looks like the perfect solution for older machines that fall short of Windows 11's specs as, in the developer's words, it will run on "basically any computer that also ran Windows 10".

That might leave you wondering why Microsoft, with all of its resources, didn't manage the same. The answer is most likely that Microsoft didn't want to: its goal was to ship a feature-rich operating system that was a genuine step up from Windows 10, rather than a minimized working environment.

Tiny11 developer NTDev hasn't stripped out everything. Accessibility features and smaller apps such as the Calculator and Notepad, plus Windows Terminal and PowerShell, have all been retained. Microsoft Store is also in there, so you can update applications and add new ones as required. You can download Tiny11 from tinyurl.com/3fuv436s.

KEEP OLD HARDWARE RUNNING

The most obvious benefit of Tiny11 is that it should continue running efficiently on older hardware over the longer term, not merely the next year or two. Nor does it comes with Microsoft bloatware: both Edge and Teams have been removed. You can add them from the Microsoft Store, or choose an alternative browser and log in to Teams on the web.

There are two versions of Tiny11 available, one of which is designed for older hardware that lacks support for TPM2; this handles on-device encryption, and was a key requirement blocking many from upgrading machines. Neither does Tiny11 require secure boot.

SAVE YOURSELF FROM MANUALLY DEBLOATING

You could install a regular build of Windows 11 and strip out the features you don't require. There are utilities to help you achieve this, such as Debloos/BloatyNosy (tinyurl.com/5n99afvw), which can analyze your system and remove what it considers bloatware, or give you the option of removing components you don't need and have no plans to use.

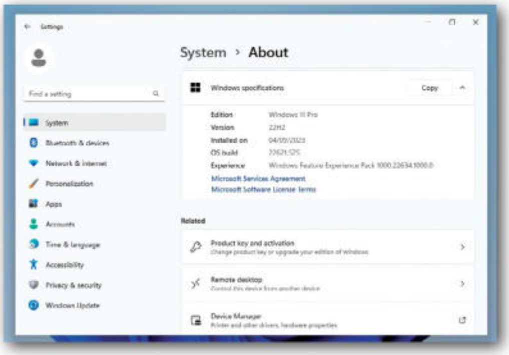
However, you can only access post-production apps such as BloatyNosy if you've installed Windows 11. Tiny11, on the other hand, is an all-in-one solution where installation is possible because it's been stripped down in advance.

RUN THE APPS YOU KNOW

The benefit of sticking with an operating system based on Windows 11 is that you can continue running the applications you use. There's no need to use a workaround such as WINE under Linux, nor is there a need to learn how to use a new OS or apps. You can avoid converting your data from its original formats, too.

USE A LOCAL USER ACCOUNT

By default, Tiny11 uses a local account, rather than a Microsoft account, so your activities are less intimately linked to your profile (you can revert to a Microsoft account if you prefer). If you're particular about your privacy, this could be a reason to switch on its own—particularly as Microsoft is now encouraging Microsoft account login as the standard option.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Microsoft Services Agreement
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Product key and activation
Change product key or upgrade your edition of Windows
Remote desktop
Control this device from another device
Device Manager
Printer and other drivers, hardware properties

Edition Windows 11 Pro
Version 22H2
OS build 22621.525

ABOVE Tiny11 is based on Windows 11 Pro, for which you'll need an activation code.

IT'S IMPROVING ALL THE TIME

Tiny11 hasn't come out of nowhere—it's a follow-on from Tiny10, so has been in development for several years. As such, it's improving over time. The first release achieved its small size through the removal of the Windows Component Store, which made it impossible to add features and languages. However, release notes for the latest build state that Windows Component Store is back, as is the removal of sponsored apps.

WHY NOT TINY11?

Are there reasons not switch to Tiny11? Sure. First, it isn't an official build. It's not supported by Microsoft, and there's no guarantee it will work in the future.

Neither is Tiny11 free. If you don't already have a code to activate Windows 11 Pro, you won't be able to activate Tiny11, so if you're installing it as a money-saving measure, I'd recommend another look at Linux. (In fact, unless you absolutely have to run Windows, that's still what I would recommend people do.)

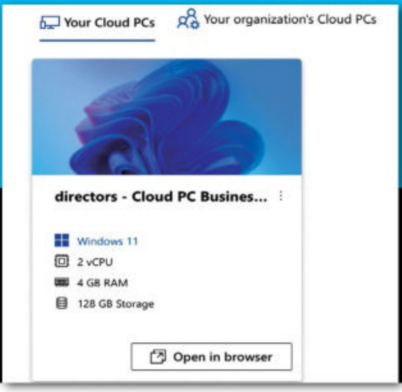
Tiny11 may be the best-known stripped-down Windows 11, but it isn't the only option. Ghost Spectre 11 (tinyurl.com/227nyrhx) lets you install a build on machines without TPM support.

ReviOS (tinyurl.com/4vc7u5h8) is another stripped-down OS, removing tools such as Photos and Windows Mail. It also avoids pre-installed apps such as Disney, plus core features such as the Telemetry Client, screensavers, and themes.

In short, you have choices: download, play, and consider your options.

Windows 11 in the cloud

There is a novel, if painfully expensive, option: stream a Windows desktop instead. **Jon Honeyball** delivers his verdict


Your Cloud PCs
Your organization's Cloud PCs
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Windows 11
2 vCPU
4 GB RAM
128 GB Storage

Windows 365—not to be confused with Microsoft 365, the new name for Office—has been under the radar for more than a year now. It allows you to stream a Windows 11 desktop to pretty much any device (or Windows 10, for that matter).

Microsoft offers a free month's trial of Windows 365 before you have to commit to an annual subscription. However, when my colleague Barry Collins tried to sign up, it was an exercise in frustration: the procedure flopped at the payment screen, at which point he was given an error code and told to call Microsoft. I'll save you the pain that stemmed from that.

So what do you get? A Windows session that you connect to from your PC, Mac, or tablet, running in a window in a browser. You can connect via other technologies, but I suspect most will use a browser like Edge. Just for fun, I used Safari on a Mac.

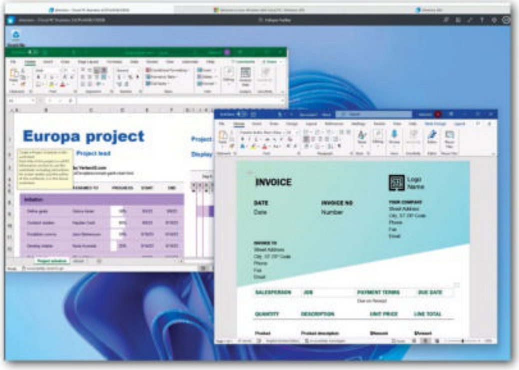
Once your account is set up, you need to subscribe to the level of capability that you want, and add it to your account. For most users, this will be done by their business administrators. I chose the Windows 365 Business plan, which offers three levels of hardware: Basic for $31 per month plus VAT gives two vCPUs, 4GB of RAM, and 128GB of storage. That's not a lot of capability, especially for RAM. With nothing running, about 3GB was taken already. However, it didn't hesitate much with Word and Excel running, so will be fine for single-task operation.

Next is Standard at $41 per month, which doubles the RAM to 8GB; you can also choose Premium at $66 per month, which increases the CPU to four vCPUs and 16GB of RAM, again with storage at 128GB. The Enterprise versions offer the same pricing for the same configurations, but you aren't limited in user count.

You aren't restricted to these specs: a configurator allows for almost any combination. At the cheapest end of the scale, you get a two-vCPU system with 4GB of RAM and 64GB of storage, which in terms of specs, matches the worst possible system you'll find on the shelves at Best Buy, yet still costs nearly as much as the Basic package. At the other end of the scale, you can rent an eight-vCPU system with 32GB of RAM and 256GB of storage, but at neary double that of the Premium package.

There's also a Windows Hybrid mode, which allows you to run Windows 10 or 11 Pro on existing hardware, reducing costs by 10 percent.

Each setup comes with Office preinstalled, but you'll have to use one of your own licences. The Basic level supports Teams only for chat and audio calls, not for video.



TOP The Basic version of Windows 365 costs around $31 per month. MIDDLE Each setup comes with Office preinstalled, but you'll need a licence. BELOW Your selection of apps is quite limited, even on the top tier.

WHY CHOOSE THE CLOUD?

So what are the top reasons for using this? First, Microsoft takes care of all OS updates, security updates, and apps. Second, it's portable. Since you usually access the instance from a browser, you can get to it from almost any device.

Reason three? It's going to be largely immune to any compromises of the client, as the whole session runs in the cloud. Four: the session never ends, and you don't shut it down; it freeze-dries until you log in, picking up where you left off. This can be good if you move between devices, making it fine for anyone who wants Microsoft Office and a browser.

However, there are downsides, one of which is cost. This is really quite expensive compared to the price of a desktop or laptop, especially over a multi-year period. Second, your options for adding third-party apps or other items is constrained. Streaming is only for the Office plus browser community.

This ties in to the next big problem: there's no obvious migration path from your PC to the cloud. Although it would be complicated, it would be nice to have a "suck the brains of my desktop and park it in my cloud Windows please" applet. You need to think of this as a clean start in a clean Windows session.

Finally, this is for businesses only. It isn't a Windows Home-oriented product. While it might at first seem the ideal solution for an aunt or wayward teenager, the inherent complexity of licensing for the business and enterprise customer puts it out of reach for domestic users.

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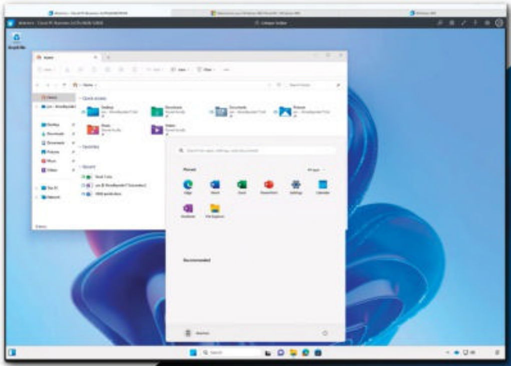


Windows 10 end-of-life security reality check

Davey Winder explains how vulnerable you'll be if you decide to carry on using Windows 10 past its sell-by date

Windows 10 is not yet an ex-Windows. It is not preaching to the choir eternal, and it has not ceased to be. Yet, it will soon become as dead as the parrot in that famous Monty Python sketch. So what will this mean in terms of the security of your data?

Dates and details are important. Windows 10 Home and Professional 21H2 won't get any more security updates, having hit end of support on June 13 2023. Organizations running Education and Enterprise versions have until June 11 2024.

If you've updated to version 22H2 then security updates will continue until October 14 2025. Note that this applies to all versions, including Education and Enterprise.

RUNNING WINDOWS 10 AFTER OCTOBER 14 2025

The security implications of continuing to use a legacy version of Windows long after the security updates have stopped are best illustrated in one word: WannaCry. The May 12 2017 worm was spread using a vulnerability within the Microsoft Windows server message block (SMB) protocol—a vulnerability that had been patched two months prior. Organizations that hadn't yet patched, or couldn't patch as they were running unsupported versions of Windows, were most exposed.

Recent research revealed that 76 percent of the vulnerabilities used in ransomware attacks in 2022 were at least three years old. The oldest dated from 2012. These were not all Windows vulnerabilities, of course, but it does stress the importance of keeping up to date with patching.

While there's no such thing as absolute security, there is a spectrum of better to worse, and end-of-life software swings you heavily towards the latter. Unpatched vulnerabilities spring to mind, but collateral damage also comes into play. Not least, compliance issues in regulated industries, legal liability if a breach can be shown to come back to an unsupported system, and even the likes of Cyber Essentials Plus certification not being available, which could swing your customers away to competitors.

REAL-WORLD SECURITY MITIGATIONS

The requirement for a TPM 2 chip to run Windows 11 means that a lot of older hardware isn't up to the job, and upgrading large numbers of machines is not an option for some businesses. However, most new computers will be compliant, and there aren't too many UI issues when switching from 10 to 11—certainly not as many as when switching from XP to 7, for example.

When it comes to the remaining mitigations, these can be split into three groups: high-cost, wing and a prayer, and practical.

The high-cost option will be if Microsoft offers extended support. This has been the norm historically, and while there's no guarantee that it will happen with Windows 10, I'd be extremely surprised if it didn't. I'd be equally surprised if the cost wasn't enough to bring a tear to any finance director's eye—a cost that increases with every year it's renewed. Migrating to Windows 11 will likely sound cheap by comparison.

Then there's the wing and a prayer option, by which I mean the simple fact that Microsoft has a history of releasing "emergency" security updates for unsupported software when the circumstances are severe enough: WannaCry patches for XP and Vista in 2017, PrintNightmare patch for Windows 7 in 2021. The problem is that for each of these critical situations, there are hundreds of critical and high-rated vulnerabilities that will go unpatched. Relying on out-of-band emergency updates doesn't make for a workable security policy.

PRACTICAL MITIGATIONS?

This brings us nicely to the answer for most people, most of the time: the practical mitigations. Faced with criminal actors who will be actively looking to exploit unpatched Windows 10 vulnerabilities, there are numerous things you can do to mitigate the risk of your legacy machines. You will likely only need legacy support for specific software needs, so run those within a virtual environment where possible. If it's a matter of specialist hardware that can't be run virtualized, then look to network isolation instead.

You might also want to consider third-party patch providers. These tend to fall into two camps: virtual patching and micro-patching. The former has the advantage of speed, as it applies an additional security layer using pattern-matching to spot known vulnerabilities. This is also a weakness if the attacker obfuscates that vulnerability pattern. Micro-patching, the best-known example being 0Patch for Windows, acts like a traditional vendor patch, correcting the vulnerable executable code. 0Patch often releases patches before an official Microsoft patch is available.

Let's conclude things with a reality check: the best risk mitigation is to upgrade to the latest Windows operating system. ⏻

CENTERFOLD

PERFORMANCE GEAR LAID BARE

Hyte Y70 Touch Chassis

TOM CLANCY'S FAVORITE PC CASE... PROBABLY. Cases have been, for the longest time, pretty dull. They house your components, and that's about it. Some come with the odd flicker of RGB, or some nice cable management touches, but usually that's it. There's no flair, flamboyance, or excitement.

Hyte's Y70 Touch, though? This is different. The company took the world by storm with the launch of its Y60, throwing the rulebook into the scrap heap and building something entirely different. It not only looked incredible; it didn't cut any corners when it came to both build quality and feature set. From intelligent cable management and small, subtle features you didn't know you needed, to PCIe 4 risers and more, it subverts expectations, and then some. But how do you improve on perfection? From such incredible dynamism? From top-tier engineering and marketing prowess? Simply by releasing this, the Y70 Touch.

Is it affordable? No, you could buy a mid-range GPU for that price, or a solid Core i7, or Ryzen 7. But is it beautiful? Yes. One tiny addition to this case has made it an absolute standout, and the lengths Hyte have gone to refine its first market-defining icon to a point beyond perfection is nothing short of incredible. Without further ado, let's take a look shall we?

–ZAK STOREY

1 BACKWARDS COMPATIBILITY

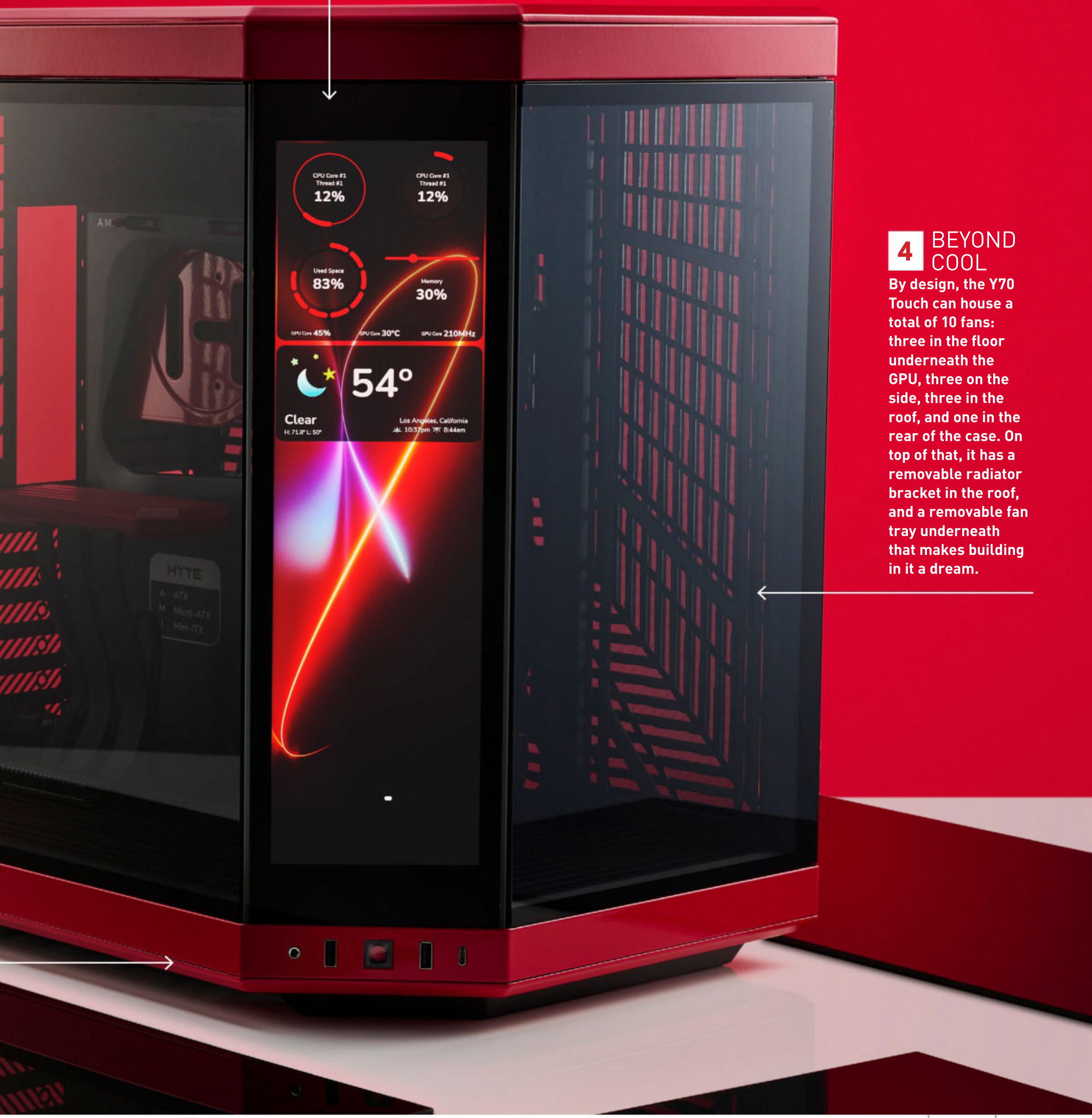
Unlike other case manufacturers, Hyte has also introduced an LCD DIY kit for its Y60 chassis as well (for $150). If you already own the last model, and don't want to change everything out, you can swap that angled panel for the upgrade kit instead. That said, you lose out on the better cooling capacity and slightly larger volume if you go that route.

2 COLOR SCHEMES GALORE

Hyte sell the Y70 Touch in four separate colorways: all black, white and black, all white, and red. But there's more to it than that. This isn't just a cheap old finish; this is a powder-coated gloss finish that's fit for royalty.

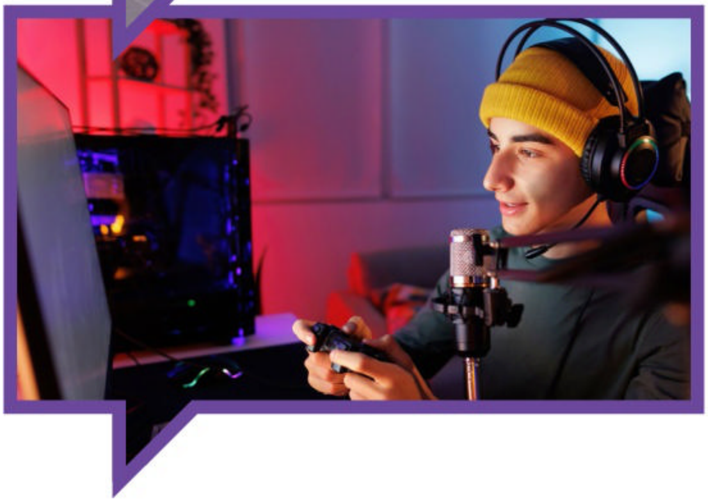
3 CRYSTAL CLEAR DISPLAY

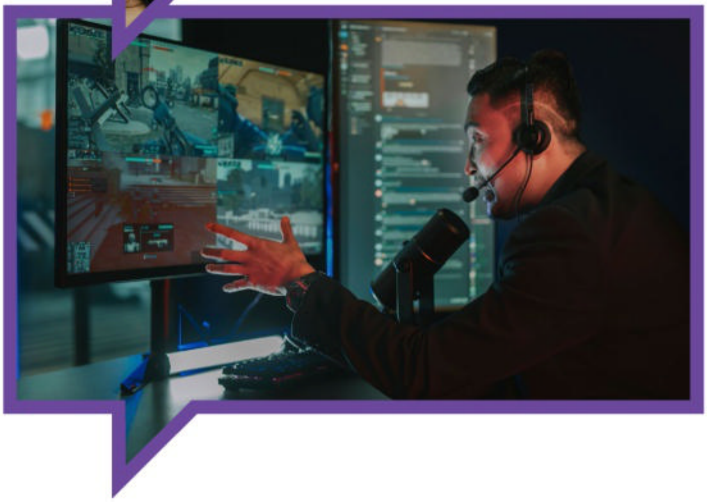
That's right, the Y70 Touch comes with its own built-in 14.1-inch 1100x3840 IPS touchscreen. Running via a passthrough directly into your GPU via DisplayPort, this 60fps beauty can run everything from *Doom* to Windows, as well as all of Hyte's integrated and intelligently designed widget setups. The versatility on this is insane.


CPU Core #1
Thread #1
12%
CPU Core #1
Thread #1
12%
Used Space
83%
Memory
30%
GPU Core 45%
GPU Core 30°C
GPU Core 210MHz
54°
Clear
H: 71.8° L: 50°
Los Angeles, California
10:37pm 8:44am
HYTE
ATX
Micro-ATX
Mini-ITX

4 BEYOND COOL

By design, the Y70 Touch can house a total of 10 fans: three in the floor underneath the GPU, three on the side, three in the roof, and one in the rear of the case. On top of that, it has a removable radiator bracket in the roof, and a removable fan tray underneath that makes building in it a dream.





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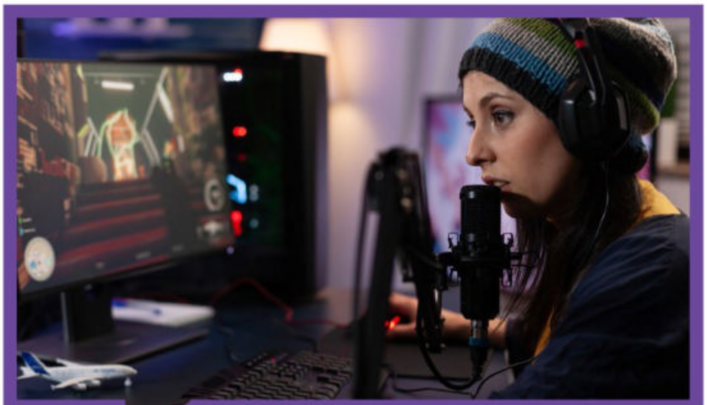


WELCOME TO STREAMING SCHOOL

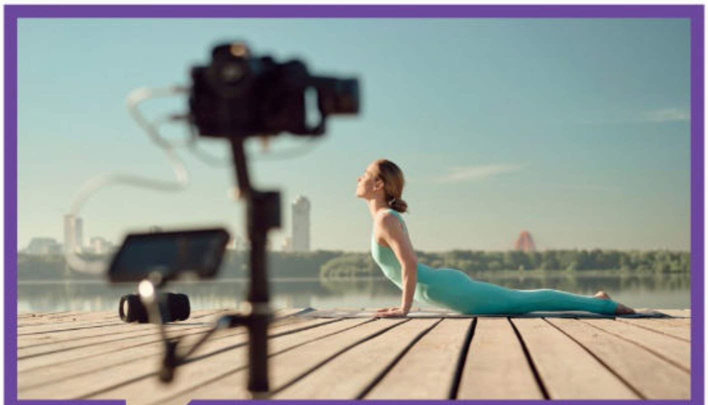
How to get started streaming on Twitch and what hardware you need for it

UNLESS YOU'VE BEEN HIDING under a rock for the last decade, you'll be aware of Twitch. Complete with an arsenal of influencers, journalists, athletes, astronauts, and more, all of them vying for your time, money, and interactions, and hopefully entertaining you in the process.

It's an incredibly dynamic platform, radically different from any other form of entertainment, and has some of the most passionate communities out there, all centered around personalities and talent from all walks of life.

Into *World of Warcraft*? Watch the race to World First. Big into *Counter-Strike 2*? Watch the best players across the planet duke it out. Looking for a *Dark Souls* challenge run guy? You can see that too. Want to watch a native Kiwi Maori carve up some beautiful pieces of wood? They've got that. There are a lot of humans doing a lot of cool stuff, and you can bet your bottom dollar that they're on Twitch, too.

But what if you want to give it a shot? Maybe you've got a passion project you want to share with the world, are keen to stream some gameplay with your buddies, or are just curious if it's something you could take forward into a full-blown career. Where do you begin? Well, don't worry, as we've got your back. We've worked closely with expert Twitch streamers and content creators the world over, to come up with a guide on how to get started in the world of Twitch. We'll cover everything from hardware considerations to stream overlay and setup, along with a plethora of tips and tricks to get you set on the path to Twitch fame and glory.



HARDWARE REQUIREMENTS

WHEN TWITCH FIRST BLOSSOMED onto the world stage, gaming PCs were in a very different place. Screen recording required some serious hardware to pull off, and programs like Fraps ate up frame rates and system resources incredibly quickly. In fact, it was very common for dedicated Twitch streamers to run not one, but two separate systems: one for the heavy-lifting video encoding and uploading (acting primarily as a passthrough system), and the other for the actual game they wanted to, you know, play. Crazy, right?

For many, the barriers to entry were just too great. Fortunately, a lot has changed since those early days, and with GPUs and CPUs now coming with dedicated streaming and video encoding componentry embedded directly, the actual system requirements to get going are starting to become fairly average. Take Twitch's own Studio recommended specs listed here—that's a GPU almost as old as this journalist's career, at this point.

TWITCH STUDIO RECOMMENDED SPECIFICATIONS

OS	Windows 10 64-bit
GPU	Nvidia GeForce GTX 10 Series or above
RAM	8GB+
CPU	8 thread Intel or AMD processor

That aside, Twitch does point out that a lot of the system requirements come from what video encoder you decide to use as standard for your stream. OBS takes that one step further, providing a list of encoders to be used in order, depending on what you're doing, and how greatly it impacts performance.

The TL;DR is effectively to run the highest possible encoder for local recording (if you're planning on just uploading the content to YouTube, TikTok, or wherever after the fact), with high-bitrate top-quality audio. OBS ranks the encoders from best to 'worse', AV1—HEVC—H.264. 'Worse' is a highly subjective term there, as H.264 will be your go-to for live streaming.

GAMING TAKES ITS TOLL

Realistically, a lot of the system requirements are going to be dependent on what exactly it is you want to stream. If you're just chatting with fans, or running a podcast or a watch party, then the hardware requirements are going to be significantly less than, say, grinding out *Elden Ring*, or jumping into competitive *Total War: Warhammer III*.

At a minimum though, you're going to want something along the lines of an Intel Core i5 10 series or Ryzen 5 5600X and above to really get a smooth experience. Along with a GPU in a similar bracket, an RTX 2070 or 5800 XT should do the trick, along with 16-32GB of DDR4 to get you started (and a suitable SSD—you don't want to keep your fans waiting on loading screens, after all).

STREAM QUALITY

Aside from generating presentable frame rates for your audience, you're also going to want to consider your stream upload quality. This is going to be affected by your video encoding settings we discussed earlier, including bitrate, display resolution, and of course, network stability.

Streaming at 1080p is the preferred resolution, even today. First and foremost, it's a convenient file size that will help keep both your upload traffic and your audience's download size low. Similarly, you'll also need to bear in mind what exactly your audience will be watching you game on so far as screens are concerned, particularly when it comes to aspect ratios. Ultrawides are great, and the 3440x1440 experience, particularly in RPGs and RTS titles, is dreamy, but for the majority still using 16:9 displays, it's not going to present an enjoyable watching experience on their device.

All of these are things that you'll need to consider when setting up your stream. Of course, you can game at 2560x1440 or 4K and downscale to 1080p, or even stream at those scales, but this will require some minor tweaking to ensure that the level of quality remains consistent. Typically, professional streamers will opt to have a multi-monitor setup. Many will be using a portrait monitor to keep an eye on Twitch chat or Discord, a 1440p or 1080p screen for their main 'streaming' gameplay, and an ultrawide or similar 16:9 panel for everything else. Of course, it's worth bearing in mind that this is highly dependent on each streamer's preference—for instance, we've seen some with upwards of five screens on at any given time.

AMD VS INTEL VS NVIDIA

Encoding is a bloody business, and there's a lot more depth to it than what we can go into. Currently, almost all modern mid-range and above GPUs have dedicated video encoders built in. Nvidia has the NVENC encoder, and AMD has AMF HW, with both supporting OBS, XSplit, Streamlabs, Twitch, Discord, and more, while also developing their own streamer aids and programs in the form of Nvidia Broadcast and AMD ReLive.

The argument for using a GPU-bound video encoder revolves around shifting the load away from the CPU and onto the GPU instead, using that dedicated silicon. However, this does increase load on the GPU, and given most games struggle to take advantage of modern processors, and both Intel and AMD have been improving their H.264 encoding capacity with each generation of processor, it's a hotly contested fight.

Which is best? Well, that's going to vary based on a number of factors we sadly can't control, including your network speed, as well as other system specs.

A big part of streaming is the testing process. It's advisable that you run a few test streams first. Play around with encoders, see what works, what doesn't, what has an impact on your frame rates, and what the quality is like. Do this before you even begin to advertise the fact that you're going live—the last thing you want is to spend two hours tinkering with settings during a live stream, as that's never fun.

ALL THE GEAR

The Razer Kiyo series is one of a number of specialist streaming webcams.

SO YOU'VE GOT your minimum spec sorted, and a 1080p screen. What other hardware should you consider?

WEBCAM/CAMERA SOLUTION

This is admittedly an optional extra, but if you want the best engagement out of your audience, it's best to get that head of yours on the screen as well. You can do this via a number of ways. A cheap webcam is one solution, or at the extreme, something like a DSLR will also work nicely. Alternatively, there are now a number of specialist streaming webcams out there built specifically for Twitch and use in live-streaming, with accompanying software.

Elgato has the Facecam and Facecam Pro (the latter a 4K solution if you really want every freckle in view), Razer has the Kiyo series, with the Ultra, Pro, and X line, and Logitech has the Brio Stream and Brio 500, to name just a few. There's also a plethora of other good picks kicking around out there, too. Heck, you might even want two for a secondary angle so you can pivot to mid-stream for those critical 'reaction shots'.

MICROPHONE/AUDIO SOLUTION

This is a big one. Good-quality audio is key when it comes to audience engagement. Make sure both your voice is crystal clear, and tuned to your liking, and that you can hear the game without it creating an endless feedback loop for your stream is critical.

You could go the whole nine yards on this one and opt for a boom arm, dedicated XLR mic, and suitable amp/interface (Elgato's Wave XLR is a fantastic solution if you're looking for something plug-and-play). However, a good-quality headset mic will work in a pinch, such as the Steelseries Arctis Line or the Corsair HS80. Instead, you could get a dedicated desktop mic, such as HyperX's QuadCast S, Razer Seiren series or Elgato Wave:3, which will work just as well, but with less dynamism than the full-blown suites.

DECK
Zoom
180%
Key Light
3600 K
Master Output

The Elgato Stream Deck has plenty of useful functions.

LIGHTING

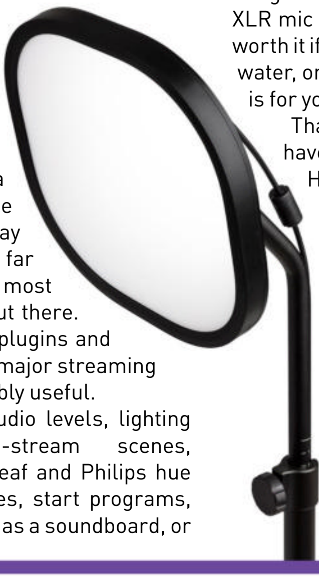
No, we're not talking about set decoration here (although that is still something you should think about), but ensuring you're well-illuminated for the stream at hand. Yep, we're talking keylights. In an ideal world, you should be illuminated from two different angles. Elgato's Keylights are a fantastic solution for this and are relatively affordable for the high-quality componentry inside. Pair that with their compatibility with the wider software suite, and they're often a surefire pick, particularly when they're on offer.

You could opt for something a little chunkier instead, such as a ring light. These larger solutions are more expensive, but do light you via a constant circle of LEDs instead. They're also great if you're planning on streaming hobby skills or something similar. Place one overhead with a camera facing down at your hands at work, and voila, well-lit hobby streaming is a go.

THE STREAM DECK

It's hard to mention streaming without talking about Elgato's humble Stream Deck. This plucky little number has gone through a lot of iterations since its conception way back when, but it's far and away one of the most useful pieces of kit out there. With a wide array of plugins and compatibility with all major streaming platforms, it's incredibly useful.

You can control audio levels, lighting temperatures, live-stream scenes, camera zoom, Nanoleaf and Philips hue lighting, audio sources, start programs, do countdowns, use it as a soundboard, or just stick macros on. The number of uses these have is incredible.



Elgato's Wave XLR is very handy if you want something to operate straight out of the box.

Elgato was first to the game with the Stream Deck, but a number of manufacturers have begun to launch their own equivalents, including Razer, Streamplify, and others. That said, Elgato's ecosystem is far more developed, particularly when you consider it also has Camera Hub, (for Facecam settings) Wave Link (Wave audio settings), and Control Center (wireless lighting controls) all in one place. There's a lot at play here, which is why they're top of our list of parts to pick.

DO YOU REALLY NEED ALL THIS?

Not really. When you're starting out, you should keep your investment small. Make the purchases you can afford or need. Don't sweat the big ticket items. Yes, things like 4K webcams and dedicated XLR mic setups are great, but they're not worth it if you're just dipping your toe in the water, or aren't entirely sure if streaming is for you.

That said, a lot of these products have mixed versatility these days. Having a good-quality webcam and lighting is fantastic for business calls and working from home. A solid microphone rig can make your voice sound real punchy in those same calls, or bumbling around with your buds on Discord, and of course, the versatility of a good Stream Deck needs no introduction, either.

Use something like the Keylight Air for lighting.

© ELGATO,

HOW TO SET UP YOUR STREAM WITH OBS

HARDWARE COVERED, YOU'VE MET THE MINIMUM SPECS, WHAT NEXT?

YOU'LL NEED THIS

Twitch Account
Create one at twitch.tv
OBS (Open Broadcaster Software)
Download at obsproject.com/download
OWN3DPRO Overlay / Elgato Marketplace Overlay
Download at own3d.pro/ or marketplace.elgato.com/

SO, we've got the hardware side covered, and you're all ready. You've got your idea of what you want to stream, and how often you're going to dabble with it. Now, let's get the boring technical software stuff out the way, shall we?

1 TWITCH ACCOUNT SETUP

The first thing you're going to want to do is create an account on Twitch to get your channel set up and your live streaming underway. Head to www.twitch.tv and click the Sign-Up button. Enter a username (Twitch will let you know if it's taken, or compatible with their ToS, so no cussin'), and a password. Insert a phone number or use your email address, then enter your date of birth, after which a verification code will be sent to your chosen email. Enter that, and you're in.

» Left-click your blank profile picture, and head to 'Settings'. Once there, click 'Security and Privacy', then go down to Security, and set up some additional Two-factor Authentication. We recommend using Authy or Google Authenticator on your phone for this. However, test SMS codes work just as efficiently.

» We won't go into too much detail, but outside of that, there's a lot to explore here. Your profile is where you upload details about yourself, and you can go directly to your channel to edit what people see when searching for your stream.

2 OBS FIRST LOOK

Next, head to obsproject.com/download and pick up the latest version of OBS Studio. This is where you'll configure your stream settings and overlay, and set your stream. Install that onto your PC, and launch once completed.

» On first launch, you'll be greeted with an 'auto-configuration wizard'. This is OBS trying to determine what settings are best for both your internet speed and hardware settings. Select the option most relevant for you. In our case, we're going with 'Optimize for streaming, recording is secondary', and hit Next. Then, choose the resolution you want to stream at (1920x1080 is our recommendation), and the frame rate you want to stream. OBS will then ask you which account you want to connect to. Now, you can enter a Stream Key here (you can find this under Channel settings on Twitch). However, we're going to hit 'Connect Account (recommended)' instead.

3 TWITCH MEETS OBS

OBS will then open up a window asking you to sign in to Twitch. Chuck your login details in here and hit login. Once you're logged in, hit Authorize when Twitch asks you if you want to give OBS permissions. After a few seconds, you'll be back in OBS with Twitch connected. On this screen, make sure 'Prefer hardware encoding' is selected, and then let OBS run its bandwidth test to best determine your optimal bitrate (you can adjust this later if needed). [**Image A**]

» Once completed, your Twitch elements will start appearing directly in OBS as separate windows. You can move these and embed them into the program directly. Pick up and grab the Stream Chat window and attach that to the right side, then do the same with Stream Information on the left.

4 GRAPHICAL UPDATES

Now we've got your Twitch account connected, it's time to get some overlays and graphical elements on here. Stream overlays are unique graphics designs that sit on top of and frame a stream. They'll give borders to certain elements, highlight new subscribers, show donations, welcome people to the channel, and more. On top of that, they'll also allow you to swap between 'Scenes'. Each scene is a unique setup you can customize, so you can have different window sizes or graphics for each one. In-game and want gameplay to be the main focus? Set up a scene for that. Chatting with viewers? Make a scene for that, too.

» You can build these manually, but a quicker option is to use a pre-made overlay. There are a number of ways you can get these, but to start with, there are two we'd recommend: OWN3DPRO and Elgato Marketplace. OWN3DPRO has a number of free overlays you can use, while also having a premium subscription ($100-140 a year), giving you access to many hundreds of packages, while Elgato's Marketplace has both free and one-off purchases instead. Most overlays come in at $30-$40, although the latter are a little more difficult to integrate.

5 OWN3D PRO SETUP

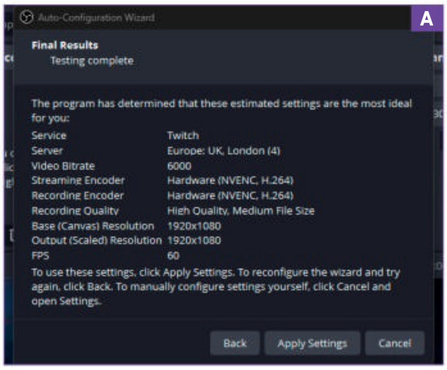
For this guide, we'll be using OWN3DPRO. Head to own3d.tv and click 'Login to Pro' on the top right. Once on the Dashboard, click 'Already have OBS Studio', then 'Download Plugin'. Download and install the plugin for OBS, then close and re-open OBS Studio.

» Once in, you'll be greeted by a new window, OWN3D Pro's privacy agreement. Agree to the terms and hit accept. Click the new OWN3D Pro option in the top bar, and select 'Overlay & Alerts Store'. A new window will open—hit login, and a browser will open. Hit 'yes log me in', and OBS will have OWN3DPRO's overlay store open in front of you [**ImageB**] .

» There's not a huge number of free skins, but this is a good place to start. Find one you like, and click the download icon. The plugin will download and pre-load it for you. We've picked up the fully animated 'Simple' overlay for this demo.

6 CUSTOMIZATION TIME

Now we've installed the overlay, you'll notice three Scenes: 'Live Scene', 'Starting Soon', and 'Just Chatting'. Clicking each one will take you to the scene in question. On the right of the Scenes tab, you'll find Sources. Think of these like Photoshop layers—the topmost element or 'layer' sits above the others, and so forth. You can also hide each layer.


A
Auto-Configuration Wizard

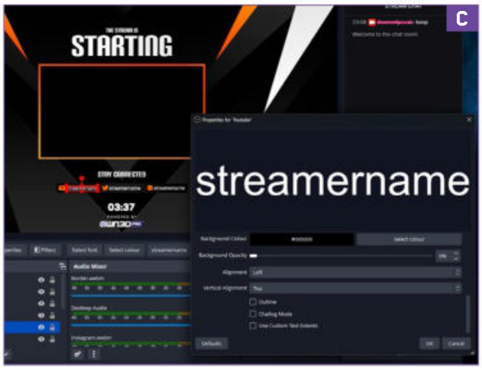
Final Results
Testing complete

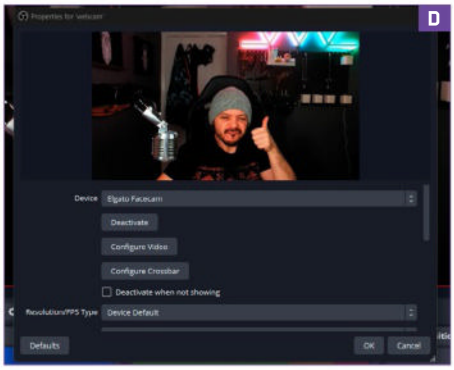
The program has determined that these estimated settings are the most ideal for you:

Service	Twitch
Server	Europe: UK, London (4)
Video Bitrate	6000
Streaming Encoder	Hardware (NVENC, H.264)
Recording Encoder	Hardware (NVENC, H.264)
Recording Quality	High Quality, Medium File Size
Base (Canvas) Resolution	1920x1080
Output (Scaled) Resolution	1920x1080
FPS	60

To use these settings, click Apply Settings. To reconfigure the wizard and try again, click Back. To manually configure settings yourself, click Cancel and open Settings.

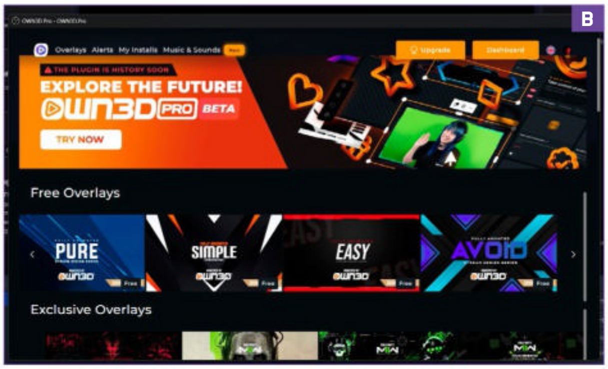
Back
Apply Settings
Cancel

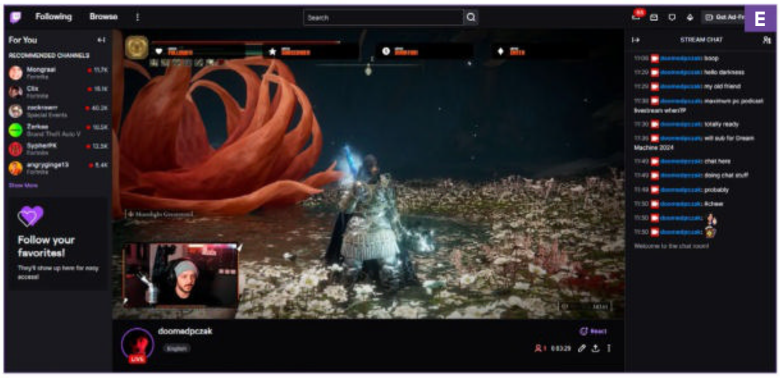

C
STARTING
streamername
03:37
Defaults
OK
Cancel


D
Properties for 'webcam'
Deactivate
Configure Video
Configure Crossbar
☐ Deactivate when not showing
Defaults
OK
Cancel

Device: Elgato Facecam

Resolution/FPS Type: Device Default


B
Overlays
Alerts
My Installs
Music & Sounds
Upgrade
THE PLUGIN IS HISTORY SOON
EXPLORE THE FUTURE!
OWN3D PRO BETA
TRY NOW
Free Overlays
PURE
SIMPLE
EASY
AVOID
Exclusive Overlays


E
Following
Browse
Search
For You
RECOMMENDED CHANNELS
STREAM CHAT
Follow your favorites!
doomedpczak

© TWITCH

» Right now, we want to edit some of the details, such as our social media names. On 'Starting Soon', click the down arrow on the 'Social Media 2' folder, then find the text for the social media you want. Double-click that, and you'll be able to change the font, the text, and more [**Image C**] . To move an element, click the source until it's highlighted with a red box, then adjust its size with the corners or move it manually by clicking and dragging.

7

GRAB THE MAKE-UP BRUSH

It's time for the final detail. First up, let's get our mug on the screen. To do that, we're going to need to add a source to each screen—in this case a webcam. For our tech demo, we'll be using the 'Just Chatting' scene to do this.

» Under Sources, click the + button, then select 'Video Capture Device', this will be our webcam. Hit 'Create new', call it 'webcam 1' or something similar, then hit OK. On the next screen, select the device you want to use as your video capture device. For us, this will be an Elgato Facecam. There are a few settings, including resolution and fps, but we're going to leave it as default (as the Facecam only records at 1080p60 anyway). Once done, select 'OK' [**Image D**] .

» You should now see that the webcam has taken over the entire screen. Similarly to the font and type, we're going to shrink this down. Then, like we would in Photoshop, we'll move the webcam layer down in Sources until it's below the other options. You will need to add this webcam to all the other scenes, depending on how you want your stream set up, but the process is the same.

8

GAME FOOTAGE EMBEDDING

Next, we'll need to do the same, but for our PC footage. We'll head to our Live Scene now. There are a number of frames for updates, alerts, and webcams. We don't need all these, though, so we can hide a few by clicking the eye icon to the right in sources. In our case, we'll be hiding Greenscreen, Greenscreen 1, and Webcam. We'll also move Webcam 1 down a smidge to the bottom right.

» Then, we'll re-add our webcam again, this time selecting from 'existing devices'. Then we need to add our game capture of choice. You can do this in one of two ways. Just like with adding a webcam, we need to add a new source. In this case, we can either do 'Display Capture', and capture an entire screen (emails and all, so be careful), or 'Game Capture'. In some cases, Game Capture can be a bit finicky on what it hooks, so we recommend either using the Display Capture method, or alternatively, using 'Capture specific window'. Once that mode is selected, open up your game, then in the 'Window' box in OBS, select the program from the list.

» Whenever that game opens, OBS will spot it, and load it with you. Once you've got the game (in our case, *Elden Ring*), hit ok, and just like the addition of the webcam, you'll have your source. Again, you'll need to resize the window, then place it below the relevant graphics overlay.

9

FINAL PREP

There are a few things we need to finish up with before going live. Look at the bottom right side of OBS, then hit 'Settings'. In the new settings window, check the 'Audio' tab, and make sure your microphone and headset (desktop audio) is set correctly. Then go to your video tab, and check that your base and output resolutions are set correctly as well.

» You'll find some pretty stellar hotkey options here too if you need them. However, we'd highly recommend getting something like a Stream Deck (or even the free mobile app) to really take advantage of those extra buttons, to swap between scenes on the fly.

» With everything good to go, you're ready to get your face on the internet. It's time to hit the big button. Click 'Start Streaming'. The button will turn blue, and you'll be live [**Image E**] .

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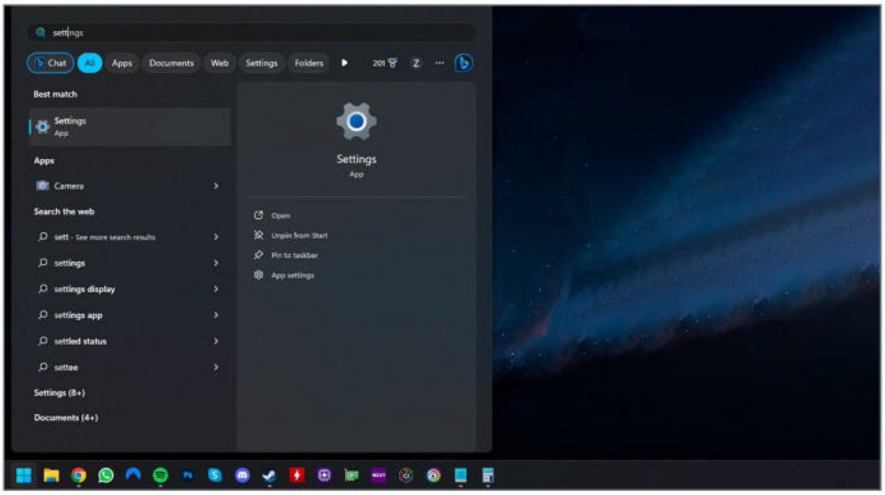
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

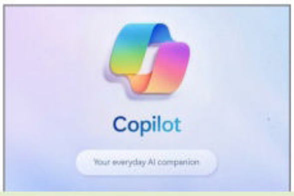
TIP OF THE MONTH


settings
Chat
All
Apps
Documents
Web
Settings
Folders
Best match
Settings
App
Apps
Camera
Search the web
sett - See more search results
settings
settings display
settings app
settled status
settee
Settings (8+)
Documents (4+)
Settings
App
Open
Unpin from Start
Pin to taskbar
App settings

CLEAN DESKTOPS

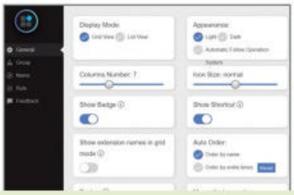
One simple trick can help tidy up your desktop and change how you use your Windows PC forever: Search. The quickest way to find a program you need is the Search menu. Click the Start menu and start typing what program, setting, or file structure you want. Windows will list a number of items you might need. Click it, and you're done. It's time to get rid of all those desktop icons, and only use it for what you need.

MAKE – USE – CREATE


Copilot
Your everyday AI companion

58
How to use Copilot in Windows 11

62
Ban intrusive ads from your network



66
Supercharge Chrome (and Edge)

© MICROSOFT, PI-HOLE.NET, GOOGLE

ZAK STOREY
CONTRIBUTOR

INTEL'S GEN 14 DEPRESSES ME

Hello there! For those of you who are new to the mag, I used to be *Maximum PC*'s editor-in-chief. I could talk for days on what I did in the interim, but there's something more pressing: the 14th gen Intel launch. More specifically, the frustration this has given me.

In isolation, these are good chips. If you grab the 14900K or 14600K and pop them in a machine today, they're fantastically potent processors. In fact, I'd argue that they're some of the best chips around right now. But compare them to last gen, and they're just seriously dull.

From a hardware perspective, the biggest change is some tweaked clock speeds. For the 14900K, that's 200 MHz boost clock increase, and APO. 14700K, 200 MHz boost clock increase, and some extra E-cores for better low-end performance. 14600K, 200 MHz extra boost clock speeds.

Intel has ensured that these chips have the same RRP as their predecessors had. With the 13 gen chips now out of stock practically everywhere, you're left with a set of new chips that don't change much, fixed in price for the foreseeable because they're 'new'.

I don't know about you, but that's utterly depressing. 14th gen might be the weakest launch I've seen from Team Blue. They're still good chips, though.

↘ submit your How To project idea to: editor@maximumpc.com

How to use Copilot in Windows 11

YOU'LL NEED THIS

WINDOWS 11 23H2
An internet connection

COPILOT IS A NEW CHATBOT in Windows 11 that can do more than just search or crack jokes. It can launch apps, change settings, generate images, and talk to you in natural language. You can type or speak to it, and it will respond to your commands and queries. It is optional, and can be ignored like Cortana before it, but offers a new way to interact with your PC without using the mouse. You can find it on your Taskbar if you have the latest version of Windows 11.

Copilot is a version of the Bing chatbot, incorporating DALL-E 3 and based on ChatGPT, that lives on your Windows desktop. You can ask it to change settings on your PC, search the web, generate images from text, and more. There's also voice input, so you can talk more naturally.

Copilot is still developing, and will get better and smarter in future updates. It is Microsoft's latest attempt to integrate an LLM into your PC, and make it more personal and convenient. According to Microsoft, Copilot is not just a chatbot; it is your assistant, but it doesn't always perform the way you might expect it to. –**IAN EVENDEN**

Copilot
Your everyday AI companion
A

1 UPDATE WINDOWS

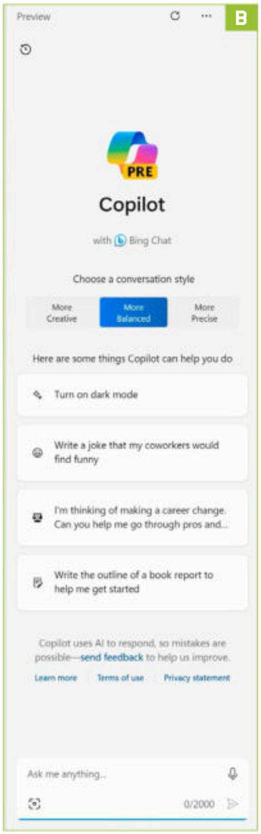
To get Copilot you're going to need the latest version of Windows 11, 23H2, though there has been talk of Microsoft bringing it to Windows 10 too. You know how to do this, but here it is anyway: open Settings, choose Windows Update, hit 'Check for updates', and let it do its thing. There has been some talk of Microsoft actually updating Windows 10 to support Copilot too, but we haven't seen any sign of it happening yet, so it may just be a rumor. Presumably, if it was to be integrated into the older OS, all it would do is tell you to upgrade.

2 FIND YOUR COPILOT

Copilot nestles in next to the Search box or button on your Taskbar, its pinky blue icon [Image A] making it look like something that conjures unicorns rather than a serious bit of AI coding. The version we're using has a 'pre' flash on it to tell us it's a preview version, though this should disappear in time. Click it, or use the Win + C shortcut, and you'll see a sidebar slide out from the right-hand side of the screen, pushing any tiled apps out of its way. This is the Copilot interface, and it looks rather unassuming. There's a text input field at the bottom, with a microphone icon so you can use your voice like Captain Kirk talking to his ship's computer. Above this, there's a disclaimer to the effect that mistakes are possible in Copilot's replies. Going up, you'll find some examples of things you can ask for, such as pop art images, details of the latest features in CSS, and weird facts about the world. Truly, there's something for everyone. Then, nearer the top, you can choose conversation styles, making the AI responses more creative or precise. Above that, you get the Copilot and Bing Chat logos, with a refresh button and a few settings at the top.

3 SIGN IN

To generate images or make more than just a few requests, you'll need to sign in. You'll need to supply the email address and password for your Microsoft account—the one you use to log into Windows—as for some reason Windows doesn't pass this information along.



Choose a conversation style

Here are some things Copilot can help you do

Turn on dark mode

Write a joke that my coworkers would find funny

I'm thinking of making a career change. Can you help me go through pros and...

Write the outline of a book report to help me get started

Copilot uses AI to respond, so mistakes are possible—send feedback to help us improve.

B

4 MAKE A SIMPLE REQUEST

The easiest way to get started with Copilot is to click one of the suggested questions [Image B]. "What is the concept of minimalism and how does it relate to productivity?" was one of the more eyebrow-raising suggested prompts we spotted, along with "Give me a list of new hobbies I could pursue with limited free time"—which raises the question of why we're not using that free time to build more PCs or play games on them—and recommendations for comedy shows on streaming services or

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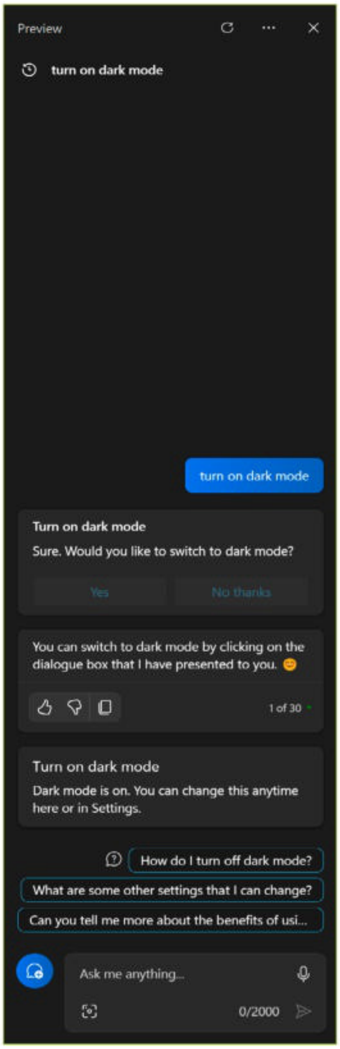


turn on dark mode

turn on dark mode

Turn on dark mode

Sure. Would you like to switch to dark mode?

You can switch to dark mode by clicking on the dialogue box that I have presented to you. 😊

Turn on dark mode

Dark mode is on. You can change this anytime here or in Settings.

How do I turn off dark mode?

What are some other settings that I can change?

Can you tell me more about the benefits of usi...

book reports. Copilot has a broad range of interests, and hitting the refresh button at the top will generate new ones. We even got one asking about a career change, and frankly we were tempted.

» If you don't feel that any of these suggestions resonate with you enough to click on them, then you can type your own in the text box at the bottom, or click the mic icon to use voice input. Whatever you choose, there will be a brief pause while Copilot communicates with whichever cloudy datacenter the LLM is running in, and you'll see the answer appear word by word just as if it were a human typing.

5 WONDER WHAT ON EARTH IT'S DOING

Copilot is new, so we're inclined to cut it some slack, but it can be baffling. Sometimes, simple requests seem utterly beyond it, while at others it responds quickly and accurately. Take a request to turn our PC's Wi-Fi on: the first response was about turning on Bluetooth, then it asked if we wanted to open the Settings app. Next came the offer of setting the PC's volume level to 100, then to turn Bluetooth off, and then to set the volume to 50. Eventually, we got a set of instructions that included clicking the network icon in the system tray, but the journey there was a bit chaotic. Type "turn on dark mode", and Copilot will do it [Image C], the change immediately reflected in your PC's windows and Taskbar once you've confirmed your decision.

6 PREPARE TO WAIT, AND CLICK

Being able to turn on dark mode like this is fine, but a question arises: would it not be quicker to just do it yourself, once you've taken into account the time it takes to type the query, the cloud server to respond to the question, the confirmation box to appear and be clicked on, and for it to finally change? This doesn't seem like an efficient use of time or resources, at least for those who can use a mouse and keyboard fluently.

» Another problem we found was that sometimes the confirmation box didn't work properly, and clicking it opened Edge, which took us to another Copilot window that contained helpful information about dark mode, which was less than ideal. The 'thinking' time Copilot exhibits, as well as the time it takes to input your prompts and requests, can slow you down if you're familiar with the locations of various settings in Windows, but could be useful for anyone who's either a newcomer to the OS, computers in general, or can't control their machine with a mouse.

YOUR GUIDE TO WHAT'S WHAT

1. REFRESH
Create a clean slate. This is useful if your Copilot window has become crowded.

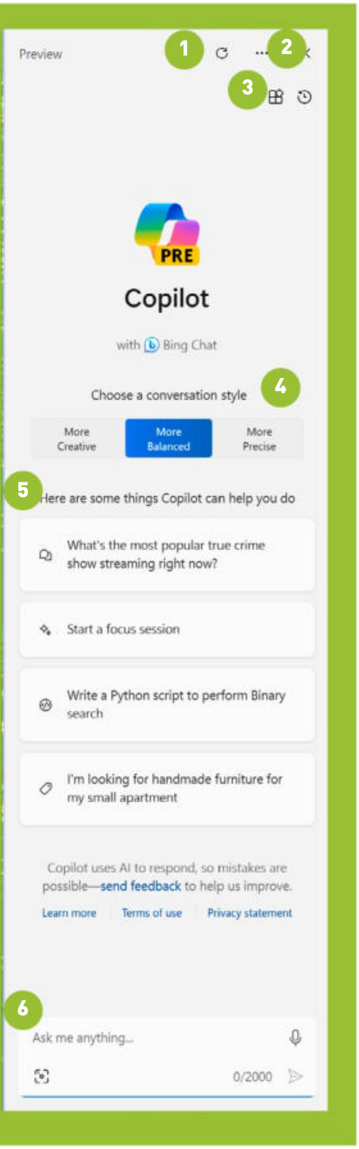
2. MENU
There's not much interesting behind here—just the option to share data with Bing.

3. PLUGINS
Add functionality from sites like Klarna or OpenTable for extra shopping fun

4. CREATIVITY
Set whether you want Copilot to go wild, or (try to) stick to the facts

5. SUGGESTIONS
Unsure what to do with your new chatbot? Try these suggested prompts.

6. INPUT BOX
Type here, or hit the mic icon for voice control. You can add images too.



Choose a conversation style

Here are some things Copilot can help you do

What's the most popular true crime show streaming right now?

Start a focus session

Write a Python script to perform Binary search

I'm looking for handmade furniture for my small apartment

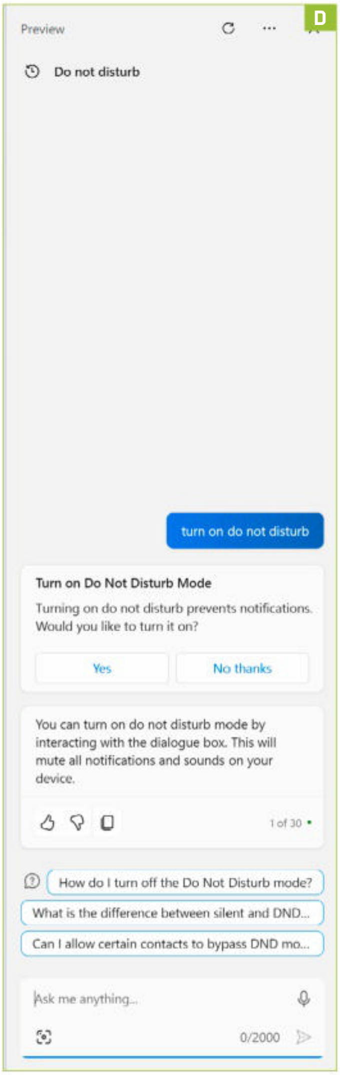
Copilot uses AI to respond, so mistakes are possible—send feedback to help us improve.

» When we asked Copilot to turn on the PC's Do Not Disturb function [Image D] to prevent notifications from breaking our concentration for a while, it provided instructions rather than taking control and changing the setting. However, its instructions were a little wonky and likely to confuse a newcomer, pointing us to a mythical 'three line' button at the bottom right of the screen when the notification 'bell' icon was probably what it meant.

7 HANDLE TEXT

Copilot can do a number of tricks with text, many of which are also found in ChatGPT, as you'd expect. Input a paragraph or two, and it can rewrite it for you, although it failed to hit a set word count, even though it claimed it had.

» We noticed that Copilot has a tolerance for typos, as when we failed to spell the word 'generate' anything close to correctly, it still managed to generate some images.


D

turn on do not disturb

Turn on Do Not Disturb Mode

Turning on do not disturb prevents notifications. Would you like to turn it on?

You can turn on do not disturb mode by interacting with the dialogue box. This will mute all notifications and sounds on your device.

How do I turn off the Do Not Disturb mode?

What is the difference between silent and DND...

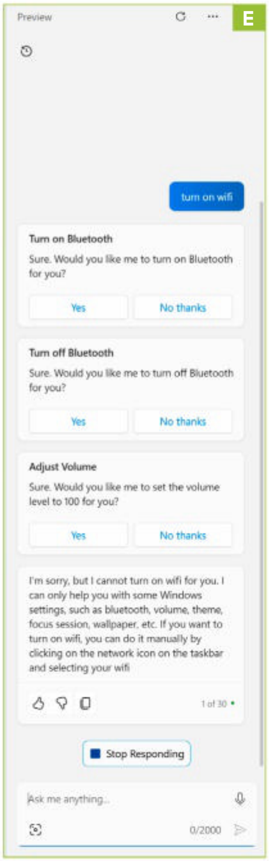
Can I allow certain contacts to bypass DND mo...

We blame years of online gaming and trying to type too fast. What did confuse it, however, was when we wrote 'wifi' instead of 'Wi-Fi', as we apparently should have [**Image E**].

8 CREATE IMAGES

One of the most interesting things you can do with an AI assistant is use it to create images of things that don't exist. Earlier this year, *Maximum PC* published a feature on how to run the Stable Diffusion AI image generator on your own PC, and highlighted some images of imaginary gaming PCs created with it. The images generated by Copilot, which uses the DALL-E 3 model from OpenAI, are much better—almost as if it understands what a PC is, and why it must be festooned with RGB lights.

» They're simple to generate. We just typed "Create images of amazing gaming PCs" into the prompt box, and it did the rest. First, it returned images it had found on the web, with links to websites we could expect to find more of. Then it generated some images of its own, creating machines with recognizable components, fans, graphics cards, and RAM. We're not completely sure about the use of running games PCs as wall decorations, as shown in some of the images, but it's definitely something worth looking into. When we asked Copilot to give the specs of these RGB monstrosities, it came up with plausible suggestions, such as i9-11900K CPUs, AMD Radeon RX 6900 XT GPUs, and anything from 16 to 64GB of RAM. It went into detail about PSUs, cases, monitors (including display tech and resolution), and even headsets.


E

turn on wifi

Turn on Bluetooth

Sure. Would you like me to turn on Bluetooth for you?

Turn off Bluetooth

Sure. Would you like me to turn off Bluetooth for you?

Adjust Volume

Sure. Would you like me to set the volume level to 100 for you?

I'm sorry, but I cannot turn on wifi for you. I can only help you with some Windows settings, such as bluetooth, volume, theme, focus session, wallpaper, etc. If you want to turn on wifi, you can do it manually by clicking on the network icon on the taskbar and selecting your wifi

9 BE CREATIVE

Gaming PCs aside, the prompts you use should be broad and not too specific—unless you want to generate images of very famous people it will be able to find with a web search. Also, animal pictures tend to look better than human faces, which can sometimes appear distorted or unnatural. It has, however, got much better at accurate humans, with the number of teeth and fingers usually within normal parameters.

» Here's an example: when we asked for "an image of someone building a pc like a mad scientist", we got four images, one of which captured the mood of the *Maximum PC* headquarters quite well, and the person depicted had natural-looking hands.

» Copilot's image creator is a handy tool for getting images for various purposes—whether you need them for a newsletter, a website prototype, or just for fun. The images are square, in PNG format, and have a default resolution of 1024x1024px, which is slightly more than one megapixel.

10 CHANGE ITS CREATIVITY LEVEL

An image of a giraffe playing PC games shows how creative Copilot can be when we adjust its setting to 'more creative'. The giraffe has a cartoonish look, a pizza slice, and three arms, which we did not specify, but it still looked impressive.

HOW DOES ALL THIS WORK?

Copilot is an LLM, (large language model) that runs in a data center somewhere on a huge rack of GPUs. It's the same bot you'll find in Bing or Edge, and Microsoft has been busy recently rebranding its various bots under the Copilot name. The underlying tech is Microsoft Prometheus, an accelerated, distributed datacenter system, and the chatbot itself uses the GPT-4 large language model 'AI', and DALL-E 3 image generator.

As a result, it doesn't run locally on your PC, and depends on an internet connection. This means there can be a lag between your text input and the answer, depending on the quality of your network and datacenter availability. Speed is also affected by Copilot's ability to search the web for more up to date answers than those provided by its training data. GPT 3.5 Turbo's knowledge base, for example, ends in September 2021. Microsoft is thought to be working on a way to increase the bot's responsiveness—though not its knowledge of breaking news—by making it possible to disable this web searching behavior. It's currently early days for Copilot, however, and many things are likely to change as updates roll in.

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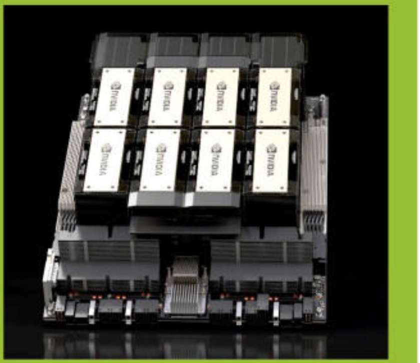
CUSTOM HARDWARE

Just as we were writing this tutorial, Microsoft announced what it calls a "systems approach to chips", and unveiled two custom-designed processors tailored for AI applications. These are the Microsoft Azure Maia AI Accelerator which will eventually underpin Copilot and is a 105 billion transistor design manufactured on TSMC's 5nm process, and the Microsoft Azure Cobalt CPU, an Arm-based processor tailored to run general purpose compute workloads on Microsoft Cloud.

Running cloud AI services can cost 10 times more than search engines, and the price of the GPU chips used has increased as demand has surged. Creating its own custom hardware allows Microsoft to sidestep this, and it's an approach taken by other players in the AI race, including Amazon with its Trainium and Inferentia chips, IBM's NorthPole, plus AMD's recently announced MI300 Accelerator. Even ChatGPT maker OpenAI is said to be looking into its own chips. Custom chips can be much more efficient than GPUs when running AI services like image classification or audio transcription, which helps to keep speeds up and costs down.

Nvidia isn't being left behind, however. Its new HGX H200 GPU (pictured) is bringing 4.8 TB/s of memory bandwidth to AI applications, and is expected to be used by Amazon Web Services, Google Cloud, Microsoft Azure, and Oracle Cloud Infrastructure, starting next year.



© NVIDIA

» AI-generated images can be very realistic at first glance, but they often have flaws that reveal their artificial nature. That's why they are more of a fun curiosity than a serious threat right now, but that could change soon.

11 GET TIPS

The introduction of Copilot into Windows 11 coincides with the Tips app being put out to pasture. We're not sure how many people actually used it, as the 'don't show again' checkbox has always been one of the first things clicked on when setting up a new PC, but now it's on the deprecated list, we won't have to worry about that anymore. Copilot is now the home of tips on using Windows, and you can type simple queries into it to get a reply based on a web search. This is fine as long as the data from the web is accurate, but luckily Copilot shows its sources, so you can judge whether you trust the site in question.

12 USE IT WITH OFFICE... BUT NOT YET

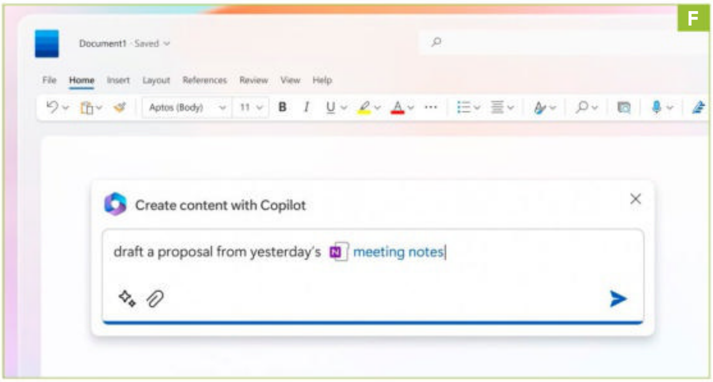
Copilot can even help you with various tasks in Microsoft 365, or at least one day it will. The chatbot is not yet available for the home version of Office—you need to have the Enterprise edition with at least 300 users and a paid subscription. Copilot will likely be integrated into all versions of Office in the future.

» If you have access to the 365 version of Copilot, you can select it from the Ribbon menu and open it as a sidebar in the app [**Image F**]. Then you can type commands or questions to ask Copilot to do something for you. For example, you can ask Copilot to summarize a long document by typing 'summarize this document' without needing to paste anything into the Copilot input box. Copilot will generate a short summary, but it will need to be checked for accuracy. The same can be done for a Teams call or chain of emails.

» Copilot can also automate many common data analysis tasks in Excel, such as "Break down sales by type and create a table". Copilot will one day be able to save office workers time and effort if its results are reliable, but it's not there yet.

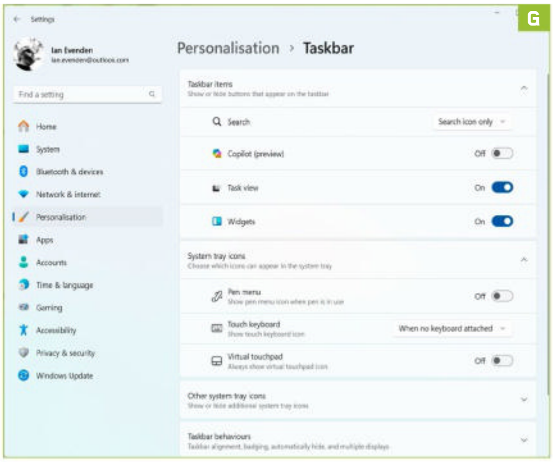
13 TURN OFF COPILOT

If you decide that AI isn't for you, and would rather its icon didn't contaminate your Taskbar any further, then you can remove it in Settings. While it only removes the icon, Copilot itself remains installed as it's now part of Windows. Open the Settings app, find the Taskbar settings in Personalization, and you'll be able to slide a switch over to the 'off' position to never see Copilot again [**Image G**]. ⏻



Create content with Copilot

draft a proposal from yesterday's meeting notes



Personalisation › Taskbar

Taskbar items
Show or hide buttons that appear on the taskbar

Search: Search icon only
Copilot (preview): Off
Task view: On
Widgets: On

System tray icons
Choose which icons can appear in the system tray

Pen menu (Show pen menu icon when pen is in use): Off
Touch keyboard (Show touch keyboard icon): When no keyboard attached
Virtual touchpad (Always show virtual touchpad icon): Off

Other system tray icons
Show or hide additional system tray icons

Taskbar behaviours
Taskbar alignment, badging, automatically hide, and multiple displays

Ban intrusive ads from your network

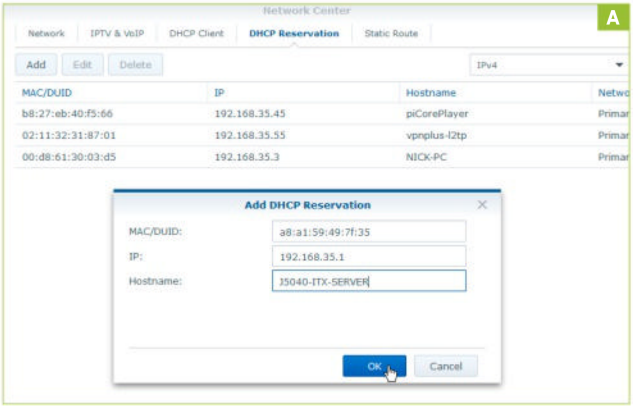
YOU'LL NEED THIS

PI-HOLE
(https://pi-hole.net), which requires Linux or Windows (through Docker or WSL)

EVERY TIME A DEVICE on your network connects to the internet—in particular the web portion of it—there's a load of junk downloaded alongside the legitimate content you want to access. Pop-up ads, trackers, and unsavory subjects are just part of it—there's the real danger of stumbling upon malware, too. By now, you've probably already made use of an ad blocker to protect your main PC, and your mobile browser may feature some limited ad-blocking tools, too.

But imagine if you could protect your network—including your smart devices—from this unwanted junk, all from one location. The good news is that Pi-hole is designed to do just that. Configure it as your DNS server—the tool used to resolve domain names like tomshardware.com into their underlying IP address (199.232.194.114)—and it'll act as a filter, screening and blocking known 'bad' IP addresses to prevent unwanted material getting on to your network.

Not only does it protect you from potentially malicious behavior; it'll speed up web browsing and boost privacy, too. Setup may look a little fiddly, but we've done all the hard work so you can get your network protected in under an hour. –**NICK PEERS**



MAC/DUID	IP	Hostname	Netwo
b8:27:eb:40:f5:66	192.168.35.45	piCorePlayer	Primar
02:11:32:31:87:01	192.168.35.55	vpnplus-l2tp	Primar
00:d8:61:30:03:d5	192.168.35.3	NICK-PC	Primar

MAC/DUID: a8:a1:59:49:7f:35
IP: 192.168.35.1
Hostname: J5040-ITX-SERVER

1 GET READY TO INSTALL

Pi-hole is a Linux-based tool, compatible with the Raspberry Pi (as its name implies), as well as major Linux distros, like Ubuntu 20.04 or later, including variants such as Mint, as well as modern versions of Debian and Fedora. It can be installed natively on these systems, while there's also a script for Windows systems that installs Pi-hole through the Windows Subsystem for Linux (WSL). A docker container is also available, although that is much trickier to set up, so we'll be focusing on the script-based native install in this tutorial.

» One major prerequisite—the PC on which you'll deploy Pi-hole (the 'host PC') should have a static IP address that doesn't change, so the rest of your network knows where to look for their DNS services. This can be done from your PC's end—Windows users would navigate to 'Settings > Network & internet', select either WiFi or Ethernet, then change the IP assignment from automatic to manual—or you may be able to do it from your router's end if it supports DHCP reservation, which basically instructs your router to permanently assign a specific IP address to a device based on its MAC address.

» For example, on Synology routers, you'd first open Network Center > Status > Device List tab'. Identify your PC from its network name, then make a note of its MAC address. Now, navigate to 'Local Network > DHCP Reservation tab', and click Add. You'll need to enter your PC's MAC address, plus the static IP address you'd like to assign it (the host name is optional) as shown in [**Image A**]. Click OK, and restart your PC to force the change.

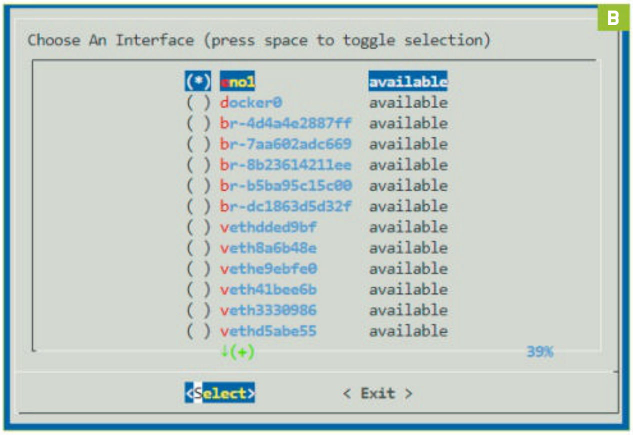
2 INSTALL PI-HOLE

If you're deploying Pi-hole directly on to a compatible Linux-based system, there's a simple one-line command to download and run the installation script (see https://docs.pi-hole.net/main/basic-install/ for details):

```
curl -sSL https://install.pi-hole.net | bash
```

» The main script provides a step-by-step wizard—you'll be reminded to assign a static IP address if you've not already done so, and when prompted to choose an interface, leave the default (typically eno1) selected, as shown in [**Image B**] . You'll be prompted to choose an 'Upstream DNS Provider'—the default Google (8.8.8.8) is one option, or you can choose Cloudflare (1.1.1.1) if you prefer, but you can change this later from Pi-hole's web interface.

» Click Yes when prompted to use the suggested third-party list, and click Yes again to install the Admin Web Interface, which simplifies the task of administering your Pi-hole settings via your browser (followed by Yes to



```
Choose An Interface (press space to toggle selection)

          (*) eno1              available
          ( ) docker0           available
          ( ) br-4d4a4e2887ff   available
          ( ) br-7aa602adc669   available
          ( ) br-8b23614211ee   available
          ( ) br-b5ba95c15c00   available
          ( ) br-dc1863d5d32f   available
          ( ) vethdded9bf       available
          ( ) veth8a6b48e       available
          ( ) vethe9ebfe0       available
          ( ) veth41bee6b       available
          ( ) veth3330986       available
          ( ) vethd5abe55       available
              ↓(+)                              39%

          <Select>          < Exit >
```

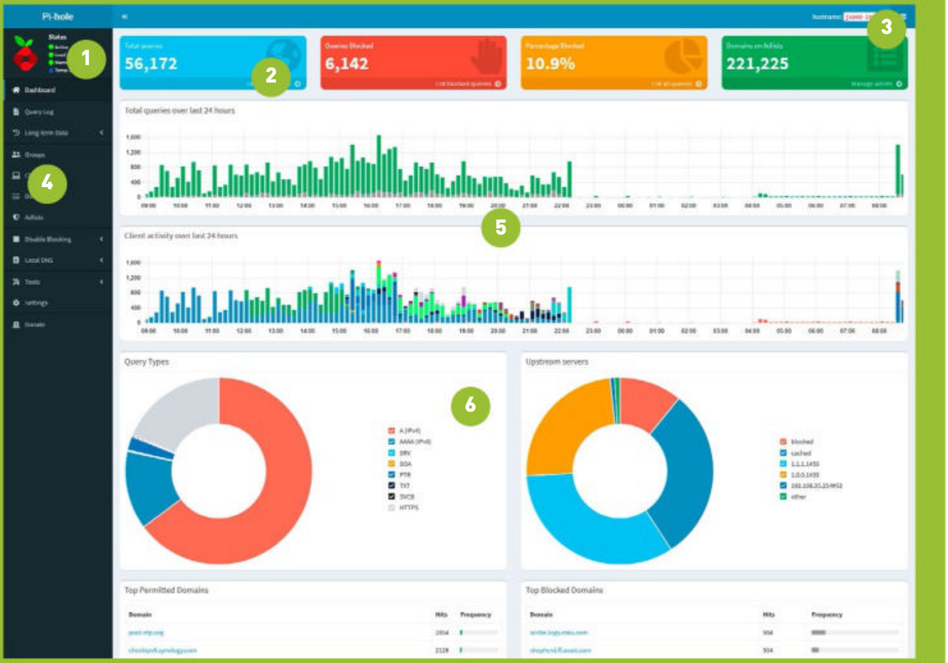
© PI-HOLE.NET

TOUR PI-HOLE'S WEB INTERFACE

1. STATUS
Get an overview of both Pi-hole's status, as well as all RAM and CPU resources—not just those being used by Pi-hole—currently being consumed by the host PC.

2. QUERIES
Each time a device on your network attempts to connect to a specific domain, it's logged as a query. Get an overview of how many queries have been made—and how many have been blocked—here.

3. MENU
Click the hamburger icon for a pop-up menu with shortcuts to online resources, like documentation and a forum. You can also log out of the web admin interface here.



4. CONFIGURE AD-BLOCKING
Use these four sections to fine-tune your Pi-hole installation—add more blocklists, plus add devices to groups to allow you to implement selective filtering.

5. REAL-TIME GRAPH
Get an overview of traffic from the past 24 hours—both total (top) and on a per client basis (bottom).

6. MORE STATS
Pi-hole is packed with useful information letting you look at what your network's up to, and what's being blocked.

the following two questions). Finally, leave 'Everything' selected under privacy—this can be changed later—and press Enter to complete the installation.

» At the very end you'll be shown the settings you need to note down: the IPv4 DNS server (basically your PC's IP address) that everyone will need to configure as their DNS server going forward, and a web address and admin login password, which you should note down.

» Windows users should download the script from the link provided at https://github.com/DesktopECHO/Pi-Hole-for-WSL1/, then right-click PH4WSL1.cmd, and choose 'Run as Administrator'. This will install any prerequisites, including the Windows Subsystem for Linux (WSL) and a compatible Debian distro, before moving on to the installation proper. If they're needed, you'll be prompted to reboot to install WSL. Then, simply re-run the script, and it'll pick up where it left off. PH4WSL1.cmd looks and works slightly differently to the native Linux script, but the main difference is that you get to pick your own web admin password rather than relying on what the Pi-hole installer generates randomly.

3 INITIAL SETUP AND TEST

Once Pi-hole is installed, open your web browser and navigate to http://192.168.x.y/admin (substitute 192.168.x.y with your PC's actual IP address), where you should be presented with the Pi-hole login screen. Enter the password you noted in the previous step and click the Log in button.

» This will place you at the main Pi-hole dashboard. Click the 'x active clients' link under Total Queries to see an overview of your network. This should confirm which devices on your network can be seen by Pi-hole (and which in turn will be able to use Pi-hole going forward). If all is as it should be, there should be a single entry highlighted in green: 127.0.0.1, or localhost. All other network devices, including your router, should also be listed in red—this indicates that they're visible and accessible to Pi-hole, but not yet configured to use it.

» Before proceeding further, let's configure a single device to use Pi-hole as its DNS server. The exact steps depend, of course, on the device in question, but on Windows 11 you'd navigate to 'Settings > Network & internet' and select either WiFi or Ethernet as before, but this time, navigate to 'DNS server assignment' and click Edit, then choose Manual from the dropdown menu and flick the IPv4 switch to On. Finally, enter your Pi-hole host's IP address and click Save.

» The change is immediate—open your web browser, and if all is well, you should be able to browse the internet as before. Now, switch back to Pi-hole's Network overview page, and refresh your browser. You should see your PC listed in green, indicating that it's connected and successfully using Pi-hole.

4 APPLY NETWORK-WIDE

While you can manually assign DNS addresses to each device on your network in a similar fashion, it's far easier to configure your router to use Pi-hole. Using your router is the quick and obvious choice,

BACK UP YOUR DNS SERVER

What happens if your Pi-hole goes down? You'll lose internet access, that's what. The obvious solution is to input a secondary DNS server (such as 8.8.8.8 for Google or 1.1.1.1 for Cloudflare) into the relevant part of your router or device's DNS settings. That's all well and good, but the sad fact is it basically renders your Pi-hole useless, as clients may hop between the two DNS servers in any order they like (this depends, of course, on the device in question), making it all too easy to bypass the Pi-hole's blocklists.

If you're unwilling to manually switch DNS servers on your router and any affected devices back to 1.1.1.1, or whatever DNS server you previously used while you troubleshoot the problem, another solution is to set up a secondary Pi-hole device. This is a good use for a standalone Raspberry Pi, or you could set up Pi-hole on another device that if it isn't switched on 24-7, is at least available when it's needed (your main PC, for example). Input its IP address into the secondary DNS server settings in your router, and your devices will retain internet access if one goes down.

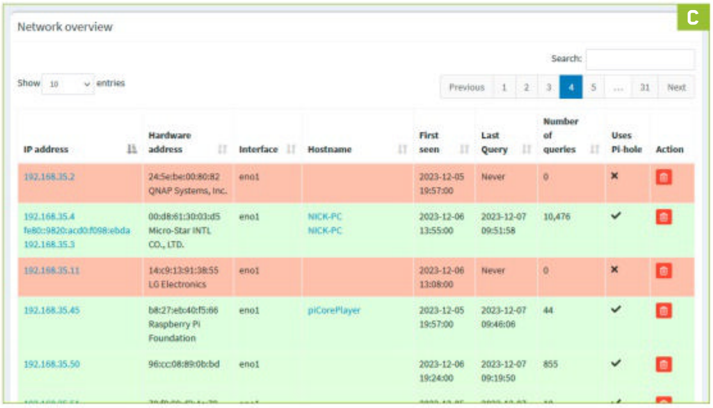
because it provides blanket coverage of virtually all your network, so only those devices with manually configured IP addresses require updating by hand. It also makes it much easier to switch back to a regular DNS server, should your Pi-hole develop problems and you need a quick route back online (see the 'Back up your DNS server' box).

» Instructions vary from router to router (see https://docs.pi-hole.net > Router setup for some guides, or Google your router's make, model, and 'Pi-hole'), but there are typically two places to look: Its internet settings, and the router's own DHCP server settings. Both options will work, but the latter—if it exists—is preferable, because it allows Pi-hole to monitor those devices connected through the DHCP server directly, as opposed to lumping all their traffic together under your router's IP address.

» On Synology routers, you'd navigate to Local Network, select Network 1, and click Edit. Switch to the IPv4 DHCP tab and input your Pi-hole's IP address into the Primary DNS field (leave Secondary DNS field blank), and click OK.

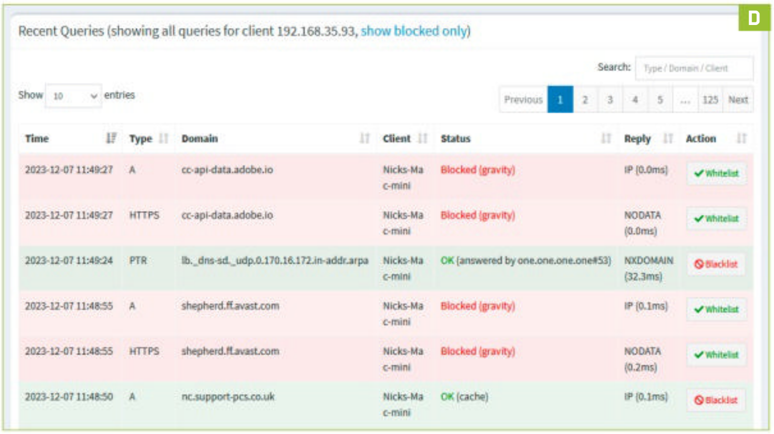
» One final step—switch back to the Pi-hole web interface and choose Settings > DNS tab. Scroll down to the 'Conditional forwarding' section, check 'Use Conditional Formatting', and enter 192.168.x.0/24 into the first box (substitute 192.168.x with your own network settings) and your router's IP address into the second box before clicking Save. This allows Pi-hole to display a device's name next to its IP address if it has one, as shown in [**Image C**] , making it easier to spot.

» If your router doesn't allow you to change DNS settings, check the 'Set up a DHCP server' box for a workaround involving Pi-hole's own DHCP server—note, this isn't available if you installed Pi-hole on a Windows PC using the script in step two.



Network overview

IP address	Hardware address	Interface	Hostname	First seen	Last Query	Number of queries	Uses Pi-hole	Action
192.168.35.2	24:5e:be:00:80:82 QNAP Systems, Inc.	eno1		2023-12-05 19:57:00	Never	0	✗	🗑
192.168.35.4 fe80::9820:acd0:f098:ebda 192.168.35.3	00:d8:61:30:03:d5 Micro-Star INTL CO., LTD.	eno1	NICK-PC NICK-PC	2023-12-06 13:55:00	2023-12-07 09:51:58	10,476	✓	🗑
192.168.35.11	14:c9:13:91:38:55 LG Electronics	eno1		2023-12-06 13:08:00	Never	0	✗	🗑
192.168.35.45	b8:27:eb:40:f5:66 Raspberry Pi Foundation	eno1	piCorePlayer	2023-12-05 19:57:00	2023-12-07 09:46:06	44	✓	🗑
192.168.35.50	96:cc:08:89:0b:bd	eno1		2023-12-06 19:24:00	2023-12-07 09:19:50	855	✓	🗑



Recent Queries (showing all queries for client 192.168.35.93, show blocked only)

Time	Type	Domain	Client	Status	Reply	Action
2023-12-07 11:49:27	A	cc-api-data.adobe.io	Nicks-Mac-mini	Blocked (gravity)	IP (0.0ms)	✓ Whitelist
2023-12-07 11:49:27	HTTPS	cc-api-data.adobe.io	Nicks-Mac-mini	Blocked (gravity)	NODATA (0.0ms)	✓ Whitelist
2023-12-07 11:49:24	PTR	lb._dns-sd._udp.0.170.16.172.in-addr.arpa	Nicks-Mac-mini	OK (answered by one.one.one.one#53)	NXDOMAIN (32.3ms)	⊘ Blacklist
2023-12-07 11:48:55	A	shepherd.ff.avast.com	Nicks-Mac-mini	Blocked (gravity)	IP (0.1ms)	✓ Whitelist
2023-12-07 11:48:55	HTTPS	shepherd.ff.avast.com	Nicks-Mac-mini	Blocked (gravity)	NODATA (0.2ms)	✓ Whitelist
2023-12-07 11:48:50	A	nc.support-pcs.co.uk	Nicks-Mac-mini	OK (cache)	IP (0.1ms)	⊘ Blacklist

» One final consideration: by default, Pi-hole's host PC isn't configured by default to use Pi-hole—this is by design to ensure it can access the internet in the event of needing to repair Pi-hole itself (pihole -r). See https://docs.pi-hole.net/main/post-install/ for an explanation and workaround if you need your host to run through Pi-hole for any reason. If you're running services through docker containers on the host, a better option is to visit https://docs.docker.com/network/ for a guide to setting custom DNS settings on a per-container basis using the --dns flag.

5 MONITOR YOUR DNS CONNECTIONS

As things stand, your network should now be protected with Pi-hole. Log into the dashboard, and you can view all kinds of stats, as showcased in the annotation opposite. To drill down further and see what connections are being made by individual devices, click the 'Xx active clients' link in the blue Total Queries box, followed by the IP address or host name of the device you want to monitor. You'll see a list of queries, color-coded to help identify those that have been blocked, as shown in [**Image D**]. You can re-sort the list and even choose to whitelist or blacklist domains, should you need to do so (note, however, that by default, these exceptions will apply to all devices, not just the currently selected one—see the following step for ways to manage these in a more granular fashion using clients and groups).

» This view can be extended to show your entire network via the 'Query Log' link on the left, while you can expand the 'Long-term Data' view, should you want to view the data shown here and on the main dashboard for a specific date and time range.

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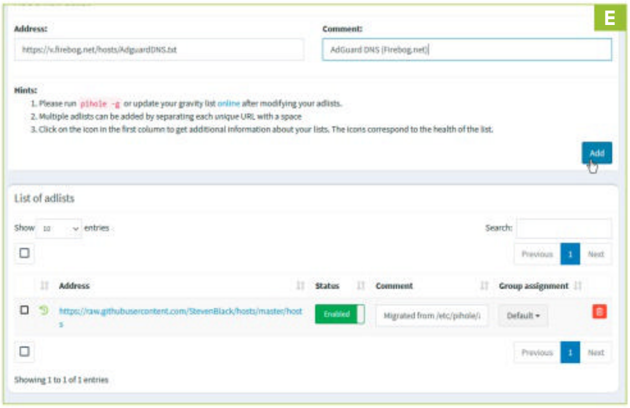


Address: https://v.firebog.net/hosts/AdguardDNS.txt

Comment: AdGuard DNS (Firebog.net)

Hints:

1. Please run `pihole -g` or update your gravity list online after modifying your adlists.
2. Multiple adlists can be added by separating each unique URL with a space
3. Click on the icon in the first column to get additional information about your lists. The icons correspond to the health of the list.

List of adlists

Show 10 entries

Search:

	Address	Status	Comment	Group assignment
☐	https://raw.githubusercontent.com/StevenBlack/hosts/master/hosts	Enabled	Migrated from /etc/pihole/	Default

Showing 1 to 1 of 1 entries

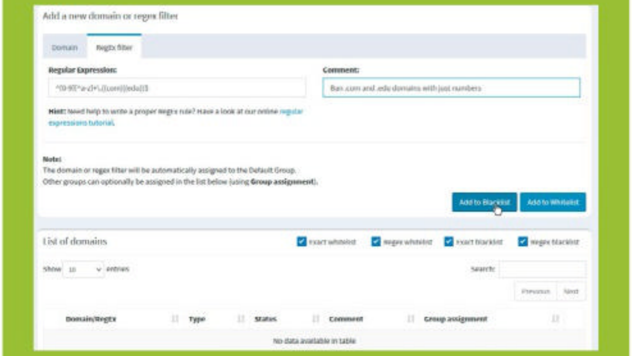
6 ADD MORE BLOCKLISTS

Pi-hole is now up, running, and your network protected by a single 'blocklist', a list of blacklisted domains that's been carefully curated to offer protection against more than just unwanted ads, but other online threats too (including domains known to push scams, adware, and fake news). For most people, this should be sufficient—just remember to periodically navigate to 'Tools > Update Gravity' in the web interface, and click the Update button to download the latest version.

» You are free, however, to add additional blocklists to increase the number of blocked domains from the 144,000 covered by the default blocklist. This can be done by selecting Adlists, then entering the URL of the blocklist you'd like to add into the Address box, followed by an (optional) comment, before clicking Add as shown in [**Image E**].

» But where do you find these blocklists? And how do you know which ones are best, and what suits your purposes? The best solution is to follow the advice at https://avoidthehack.com/best-pihole-blocklists, where you'll discover links to major blocklist repositories containing the links you need to copy and paste, along with recommendations based on what you're looking to block. Once you've added your lists, navigate to Update Gravity and click Update to add the domains in the various lists.

MANAGING WHITELISTS


Add a new domain or regex filter

Regular Expression: ^[0-9][^a-z]+\.((com)|(edu))$

Comment: Ban .com and .edu domains with just numbers

Hint: Need help to write a proper RegEx rule? Have a look at our online regular expressions tutorial.

Note:
The domain or regex filter will be automatically assigned to the Default Group.
Other groups can optionally be assigned in the list below (using **Group assignment**).

List of domains ☑ Exact whitelist ☑ Regex whitelist ☑ Exact blacklist ☑ Regex blacklist

Show 10 entries

Search:

Domain/RegEx	Type	Status	Comment	Group assignment
No data available in table				

There will come a time when certain sites or services stop working because of your ad-blocking settings. You can confirm this by temporarily disabling Pi-hole—expand the Disable Blocking menu, and choose whether to disable temporarily (sometimes a 10- or 30-second gap is all that's needed) or permanently while the site loads, and then see if you can trace the problem to a specific domain.

If you can, it can be whitelisted via the Domains section—just enter the domain name and optional description, check the box to add it as a wildcard (so all subdomains are waved through as well), and then click 'Add to Whitelist'. It'll appear in the list below where once again you can assign it to specific groups or remove it, should you wish.

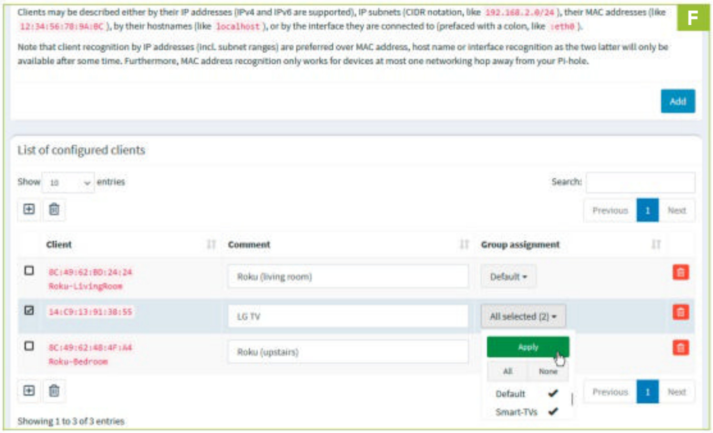
You'll also see that Pi-hole supports RegEx filters—thankfully, a 'regular expressions tutorial' link offers a comprehensive guide to the syntax used by Pi-hole, enabling you to create more sophisticated blacklists and whitelists—for example:

```
^[0-9][^a-z]+\.((com)|(edu))$
```

Add this to a blacklist, and it'll block all .com and .edu domains containing only numbers.

7 SET UP CLIENTS AND GROUPS

Your network is likely to contain a range of different devices, from your computers to smart TVs. When evaluating blocklists, you should hopefully have come to the realization that there's no one-size-fits-all blocklist for your entire network. Pi-hole recognizes this, and allows you to create groups of devices that can then be used to work with specific blocklists only.



Clients may be described either by their IP addresses (IPv4 and IPv6 are supported), IP subnets (CIDR notation, like `192.168.2.0/24`), their MAC addresses (like `12:34:56:78:9A:BC`), by their hostnames (like `localhost`), or by the interface they are connected to (prefaced with a colon, like `:eth0`).

Note that client recognition by IP addresses (incl. subnet ranges) are preferred over MAC address, host name or interface recognition as the two latter will only be available after some time. Furthermore, MAC address recognition only works for devices at most one networking hop away from your Pi-hole.

List of configured clients

Show 10 entries

Search:

	Client	Comment	Group assignment
☐	8C:49:62:BD:24:24 Roku-LivingRoom	Roku (living room)	Default
☑	14:C9:13:91:38:55	LG TV	All selected (2)
☐	8C:49:62:48:4F:A4 Roku-Bedroom	Roku (upstairs)	

Showing 1 to 3 of 3 entries

» By default, all devices are placed in the Default group, so start by navigating to Groups to create your first new group. Give it a name and description, and click Add. Next, switch to Clients and click the Known Clients dropdown menu to list all visible clients by MAC address and—if known—IP address and hostname. Select one, give it a more friendly description, and click Add. Repeat for other related clients.

» Each client will appear below this in the 'List of configured clients' section, as shown in [**Image F**]. Click the Default button under Group Assignment next to an entry, and you'll see a list of available groups—check each group you want the device to join (it can be a member of multiple groups, and thus bound to all those groups' blocklists) before clicking Apply.

» The final step is to apply blocklists to groups, which is done from the Adlists section—again, click the Default button under Group assignment. One applied, the rules are enforced for all devices in that group.

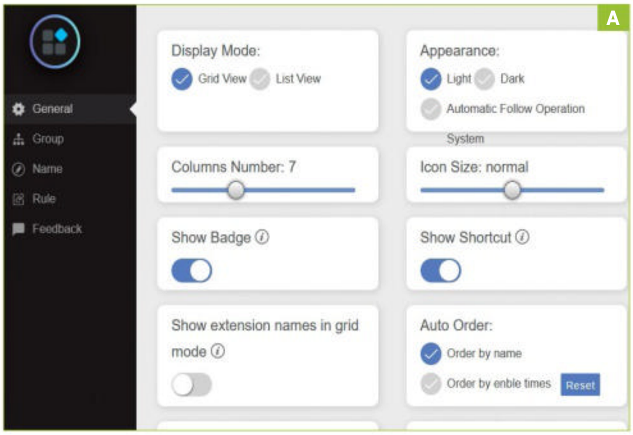
» You've now got a reliable DNS server that should reduce the number of ads and unwanted content your network is exposed to. But Pi-hole is capable of so much more—visit https://docs.pi-hole.net/ to get a fuller understanding features we've covered, as well as explore other avenues of the tool. ⏻

Supercharge Chrome (and Edge)

YOU'LL NEED THIS

GOOGLE CHROME
https://www.google.com/intl/en_us/chrome

CHROME IS THE MOST POPULAR web browser in the world, and there are good reasons for that: it's not only underpinned by one of the biggest names on the net, it's supported by an active community of extension developers. A huge library of extensions massively increases the range of tasks that Chrome can accomplish, making it as much a productivity platform as it is a window on the web. Here's our pick of eight essential extensions that can save you time and enhance your web experience, whether you're a casual browser, a power user, or an online professional. You don't even have to be using Chrome to make use of them—you can also install Chrome extensions in Microsoft Edge to get the exact same benefits (see https://support.microsoft.com/en-us/microsoft-edge/add-turn-off-or-remove-extensions-in-microsoft-edge-9c0ec68c-2fbc-2f2c-9ff0-bdc76f46b026). –NIK RAWLINSON



Display Mode: ● Grid View ○ List View

Appearance: ● Light ○ Dark ○ Automatic Follow Operation System

Columns Number: 7

Icon Size: normal

Show Badge ⓘ

Show Shortcut ⓘ

Show extension names in grid mode ⓘ

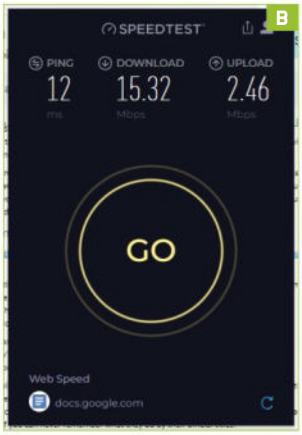
Auto Order: ● Order by name ○ Order by enble times Reset

1 EXTENSION MANAGER

https://chrome.google.com/webstore/detail/extension-manager/gjldcdngmdknpinoemndlidpcabkggco

There are hundreds of thousands of Chrome extensions in existence. While the browser might have no trouble dealing with dozens of extensions, it can quickly get confusing when you need to navigate them yourself. That's why the first extension you install should be an extension manager. Extension Manager lets you browse your installed extensions in a list or grid, import, and export extension lists, and customize the layout of the manager, with control over icon size, columns, and light and dark UI options.

» Where Extension Manager really comes into its own is its ability to switch between extension sets, depending on what you're doing. Just open the manager's settings and click Group in the sidebar to start setting up extension groups [**Image A**]; you might have one for home and another for work, or you could create task-focused groups for writing, video calls, online shopping, and so on. Each group gets its own tab on the dashboard; click through the tabs, then click on the icons for each extension that should be included in that group. Once you've set up your groups, you can instantly switch between them using the drop-down in the Manager panel. You can also create rules that automatically enable or disable extensions when you visit a specified domain.



PING 12 ms

DOWNLOAD 15.32 Mbps

UPLOAD 2.46 Mbps

Web Speed

docs.google.com

2 SPEEDTEST BY OOKLA

https://chrome.google.com/webstore/detail/speedtest-by-ookla/pgjjikdiikihdfpoppgaidccahalehjh

Is the web running slow? If it's a consistent problem, you should take it up with your ISP, but not before you've gathered some evidence. When our broadband starts to lag, we head for Ookla Speedtest (speedtest.net), which has so far performed around 50 billion tests across more than 15,000 servers [**Image B**]. Its Chrome extension lets you launch a test directly from the toolbar, making it effortless to check your broadband performance whenever you need to.

» The stripped-down interface will be immediately familiar if you've ever used the speedtest.net site. Simply click the single button to perform ping, upload, and download tests without leaving the site you're already browsing.

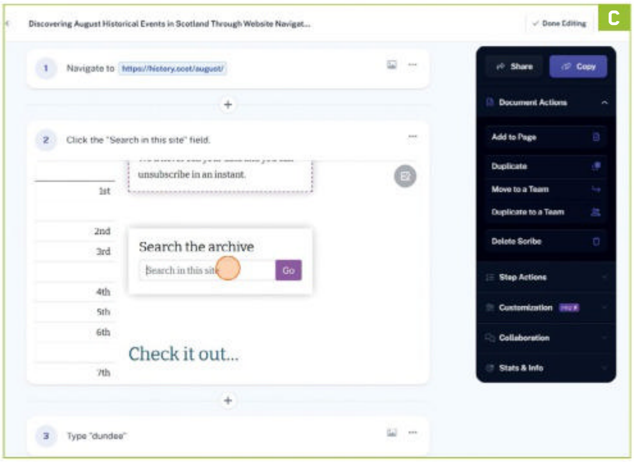
» The plugin also has a second function which is very useful for anyone running their own website: it can calculate how long the site you're currently viewing took to load. Search engines use load times as a gauge when ranking results, so reducing them as far as possible is very worthwhile. Ideally, you want your page to load in less than two seconds, or three at a push; anything longer than this needs attention. Being able to quickly check at different times of day and through different browsers will give you some real-world data to work with. To use this feature, open the extension's options, and make sure the box beside Enable Web Speed is ticked.

3 SCRIBE: AI DOCUMENTATION, SOPS & SCREENSHOTS

https://chrome.google.com/webstore/detail/scribe-ai-documentation-s/okfkdaglfjjjfefdcppliegebpoegaii

Screenshots are a powerful tool for sharing all types of information and instructions, but taking and organizing multiple grabs can be slow and fiddly. Enter Scribe. Once you've installed it and signed up for an account, it watches what you're doing and takes a

© GOOGLE



Discovering August Historical Events in Scotland Through Website Navigat...

1 Navigate to https://history.scot/august/

2 Click the "Search in this site" field.

3 Type "dundee"

screenshot of every action, including clicks, button presses, and text field entries. When you click a link, button, or field, it's highlighted, and the screenshot is intelligently cropped to put the active element at the centre of the frame without unnecessary distractions. Better yet, each screenshot is briefly annotated.

» Thus, if you want to show someone a process of clicking in a search box containing the hint 'search term', typing 'GPU', then clicking 'Go', you simply need to perform those actions yourself and you'll see three steps added to the script [**Image C**]. The first will be a cropped image of the search box, labeled 'Click the 'search term' field'; the second will be the annotation 'Type GPU' without a grab; and the third will be another cropped grab of the search box with the 'Go' button highlighted. The final annotation will be "Click Go". You can then click the 'stop' button to review your steps—at this point you can optionally edit the annotations before exporting the result as a PDF or embedding it in a web page.

» The free Basic plan is designed for browser-based tasks, but there are two other paid tiers that add support for step-by-step capture of other applications, and can export workflows in HTML or Markdown formats.

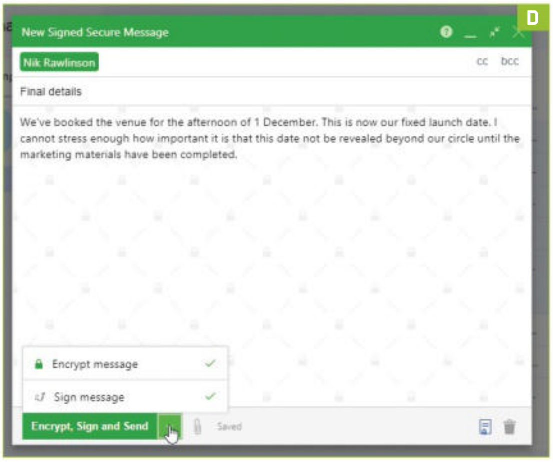
4 FLOWCRYPT: ENCRYPT GMAIL WITH PGP

https://chrome.google.com/webstore/detail/flowcrypt-encrypt-gmail-w/bnjglocicdkmhmoohhfkfkbbkejdhdgc

A VPN can secure the connection from your PC to a remote server, but its protections only extend so far. When you send someone an email, it's ultimately transmitted as plain text from their mail server to their PC, smartphone, or tablet.

» If you want a truly secure communications channel, PGP encryption can help—and FlowCrypt provides an easy way to use it within Gmail. Once you've installed the extension, launch it from the toolbar and sign in to the Gmail-hosted account you want to use. You'll need to grant it permission to see your emails [**Image D**], then create a passphrase that only you know. This is used to generate the public and private key pair that'll be used to encrypt and decrypt messages. Once you're done, log in to Gmail as usual, and you'll see that the regular Compose button has been supplemented by a Secure Compose button. When you click this, you'll get the option to encrypt, sign, or both encrypt and sign your new message before sending. If you've opted to encrypt the message and included an attachment, that will also be encrypted.

» FlowCrypt is free to install and use for domains with fewer than 100 users. There are some additional advanced features that are only available in the paid edition, but most personal users and small businesses will find all they need in the gratis



Nik Rawlinson

Final details

We've booked the venue for the afternoon of 1 December. This is now our fixed launch date. I cannot stress enough how important it is that this date not be revealed beyond our circle until the marketing materials have been completed.

Encrypt message ✓

Sign message ✓

implementation. You'll find a comparison table listing the full feature set of either tier at https://flowcrypt.com/docs/business/enterprise.html.

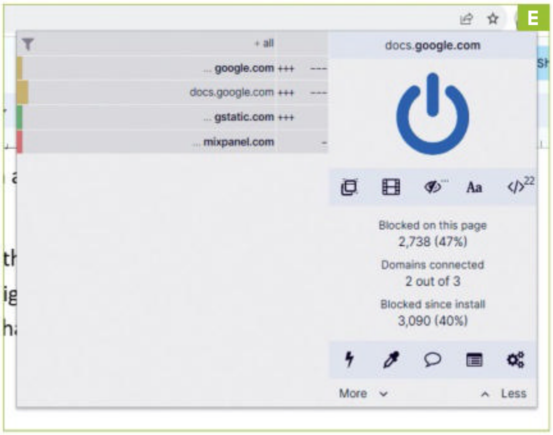
5 UBLOCK ORIGIN

https://chrome.google.com/webstore/detail/ublock-origin/cjpalhdlnbpafiamejdnhcphjbkeiagm

Another way to save resources is to block extraneous content. uBlock Origin, which is free and open source, does just this—there are official versions for Firefox and Edge, as well as Chrome [**Image E**]. uBlock Origin blocks embedded web content based on publicly available lists, which typically have specific focuses such as removing social media buttons and widgets, cookie banners, GDPR overlays, and other unwanted notices. You can choose which lists you want to use, and you can also configure the extension yourself to block popups, scripts or large media on specific domains.

» Conversely, you can mark individual sites as trusted, in which case no filtering will be applied. This can be helpful if you don't want to block resources on internal domains, or a site you rely on doesn't work properly when resources are put out of reach.

» To provide reassurance that uBlock Origin is on the up-and-up, all code—plus any ongoing changes—is available for inspection through GitHub, and if you want to support the project, developer Raymond Hill asks benefactors to donate to list maintainers rather than himself.

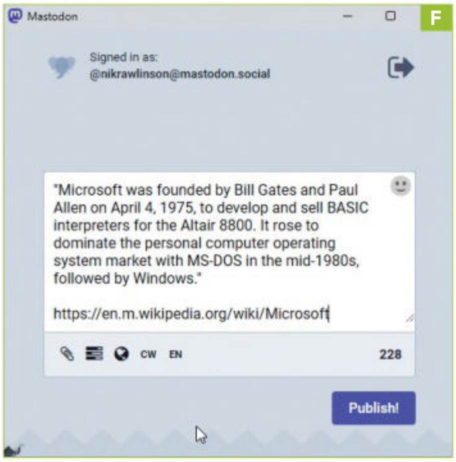


docs.google.com

Blocked on this page
2,738 (47%)

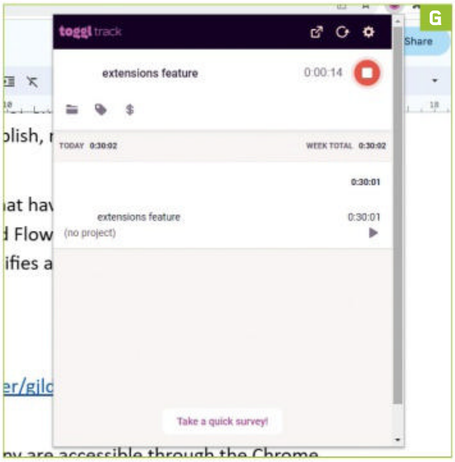
Domains connected
2 out of 3

Blocked since install
3,090 (40%)


Mastodon
F
Signed in as:
@nikrawlinson@mastodon.social
CW
EN
228
Publish!

"Microsoft was founded by Bill Gates and Paul Allen on April 4, 1975, to develop and sell BASIC interpreters for the Altair 8800. It rose to dominate the personal computer operating system market with MS-DOS in the mid-1980s, followed by Windows."

https://en.m.wikipedia.org/wiki/Microsoft


G
toggl track
Share
extensions feature
0:00:14
TODAY 0:30:02
WEEK TOTAL 0:30:02
0:30:01
extensions feature
(no project)
0:30:01
Take a quick survey!

6 SHARE TO MASTODON

https://chrome.google.com/webstore/detail/share-to-mastodon/bibnjflclpdmbbcncejifemmbggkcjde

Microblogging service Mastodon is one of the biggest social sites in the Fediverse, and its popularity is growing, hitting more than 10 million users earlier this year. It's still a long way off being a serious challenger to Facebook or Twitter—sorry, 'X'—but plenty of individuals and businesses are seeing the benefit of its open model.

» This extension makes it easier to maintain a rich presence on Mastodon. Once you've set up your home instance, a single click on the extension will create a new post containing a link to the page you're currently browsing [**Image F**]. If you want to be more specific, you can highlight part of a page and right-click to use that content as the basis of your post.

» If you've configured several instances and logins in the extension's settings, you can select between them before posting, which makes it easy to direct content to specific feeds if you're writing for several different audiences.

» Regular Mastodon user should also check out the Mastodon Air theme extension (https://chrome.google.com/webstore/detail/mastodon-air/amnafipdbahbnkhmaiiokceohldofhda): it gives the standard Mastodon layout a gentle brush-up, with control over background, text, and accent colours, as well as the ability to hide trends and About links.

7 TOGGL TRACK: PRODUCTIVITY & TIME TRACKER

https://chrome.google.com/webstore/detail/toggl-track-productivity/oejgccbfbmkkpaidnkphaiaecficdnfn

If you work from home—on professional or personal projects—an automated activity tracker makes it easy to track how you're spending your screen time. Toggl is a free browser-based solution for five or fewer users, which is ideal for home workers and solopreneurs.

» To use it you'll just need to set up an account at toggl.com, which you can do from within the extension. Answer a few questions about who you are and how you plan to use it, and you're good to go. Once you start tracking, it will watch what you're doing in the browser and keep a log. You can optionally add a manual note to each session to describe the job involved.

As well as passively monitoring your activity, Toggl offers a built-in Pomodoro timer to help keep you motivated, and there are various options for starting timings automatically, stopping at a specified time each day, or posting notifications when the timer is running but the PC is idle [**Image G**].

» Toggl integrates with an impressive range of third-party web apps, including business essentials like Xero, Zendesk, Trello, Slack, and Salesforce, and while it's easiest to enable them all up front, you can manually deactivate any that you don't want to include in your log.

8 TEXT BLAZE: TEMPLATES AND SNIPPETS

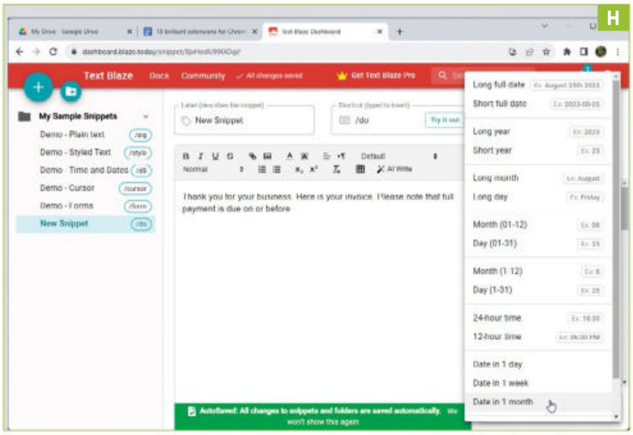
https://chromewebstore.google.com/detail/text-blaze-templates-and/idgadaccgipmpannjkmfddolnnhmeklj

Most jobs involve a certain amount of writing the same sentences or paragraphs many times over—be they boilerplate text, caveats for a standard offer, or your contact details. Text Blaze saves you time and tedium by storing these standard phrases as snippets, which you can insert into any text field by typing a shortcut with a slash. For example, you might create one with your standard email signoff as '/bye', and another with your contact details under '/me'.

» It's up to you what you choose as your shortcuts—they only have to make sense to you. Once you've set them up, typing a shortcut and pressing Return instantly pastes in the associated text. It works across all websites, and if you want to use a shortcut in a text box, you can right-click the text space and select it from the context menu [**Image H**].

» Snippets aren't limited plain text either. You can use a wide range of formatting tools, and even insert dynamic elements like the contents of the clipboard, today's time and date. Text Blaze can even calculate future dates, so if you were writing a covering note to be used every time you attach an invoice to an email, you could add a variable to specify the payment deadline as 30 days from the present date.

» The free basic plan lets you create up to 20 snippets with a maximum of 2,500 characters per snippet. Upgrading to Pro costs around $36 per year and lets you store 1,000 snippets with a maximum of 25,000 characters each, and unlocks a range of advanced features like date choosers and drop-down menus. The top-tier Business plan (around $84 per year) allows up to 4,000 snippets of 50,000 characters, with snippet change histories and usage statistics.


H
Text Blaze
Docs
Community
All changes saved
Get Text Blaze Pro
My Sample Snippets
Demo - Plain text
Demo - Styled Text
/style
Demo - Time and Dates
Demo - Cursor
/cursor
Demo - Forms
New Snippet
/do
New Snippet
/do
Default
Normal
AI Write
Long full date
Short full date
Long year
Short year
Long month
Long day
Month (01-12)
Day (01-31)
Month (1-12)
Day (1-31)
24-hour time
12-hour time
Date in 1 day
Date in 1 week
Date in 1 month

Thank you for your business. Here is your invoice. Please note that full payment is due on or before

AutoSaved: All changes to snippets and folders are saved automatically. We won't show this again

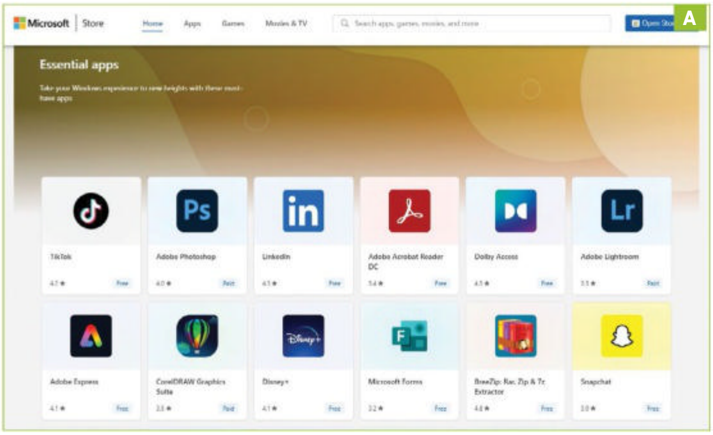
© GOOGLE

Use package managers to download safely

YOU'LL NEED THIS

WINDOWS 10 OR 11
www.microsoft.com/en-us/software-download

KEEPING YOUR SOFTWARE UPDATED is important. If you let things slip out of date, you risk becoming vulnerable to hackers and malware. You might also be missing out on useful new features in your favorite programs. Thankfully, keeping up is far easier today than it was a few years ago, thanks to automatic updates in Windows and Office and programs that check for new releases every time they start [**Image A**]. That said, anything that can simplify the process further is a bonus—which brings us to the concept of package managers. These tools help handle the job of installing and updating software. Package managers download bundles of code and descriptive data (or archives) from servers known as 'package registries'. The archives are compiled by software developers, who can vouch for the integrity of their contents by attaching what's known as a checksum. This is a long number that's calculated by applying a mathematical equation to the code within the bundle. If anything within the bundle is changed, the equation will no longer spit out the correct answer. **–NIK RAWLINSON**



A

1 LEARN HOW CHECKSUMS WORK

To illustrate this, forget about 'code' for a moment, and instead think about three simple letters: ABC. If we said that the letter A was worth one, B was worth two, and C was worth three, we could create a simple 'checksum' (effectively the output of a 'sum' used to 'check' the validity of the message) by adding those values together. The result would be six.

» We could then pass on the text (ABC) to someone else, who could in turn hand it to a third party. The third party could check that the intermediary hadn't interfered with the code by applying the same equation to the text and comparing the answer they got to the published checksum. If they got six, they'd know that the text they received hadn't been altered since we wrote it, even though they didn't receive it from us directly.

» If the intermediary—or anyone else—swapped the C in our text for another A, to give us ABA, the result of the equation would be four (1+2+1). Because this wouldn't match our published checksum, the recipient would know that something had changed, and know not to trust the message they received, since its integrity would be open to question.

» You've probably spotted that this particular implementation is simplistic and easily foiled, since the messages CBA, CAB, BCA, BAC, and ACB would also produce '6' when run through the equation. However, it serves as a handy illustration for the way that checksums work. Needless to say, the checksum system used for verifying the code can be combined with other checks that also verify its 'authenticity'.

» While integrity checks confirm that the item in question still delivers the same result when subjected to the equation, authenticity checks confirm that it originates from who we expect, even if it's passed through a third party on its journey. This can be achieved using a pair of 'keys', which are effectively long and complex numbers.

» One number (or key) is made public, and the other—called the private key—is known only to the person creating the archive you're going to download. The originator of the item in question 'signs' it using their private key, which can be verified by the recipient through

TABLE 1

Private key digit		Public key digit		Output	
13	+	3	=	16	(position P in the alphabet)
1	+	0	=	1	(position A in the alphabet)
13	+	6	=	19	(position S in the alphabet)
13	+	6	=	19	(position S in the alphabet)

TABLE 2

Private key digit		Public key digit		Output	
3	+	3	=	6	(position F in the alphabet)
1	+	0	=	1	(position A in the alphabet)
3	+	6	=	9	(position I in the alphabet)
6	+	6	=	12	(position L in the alphabet)

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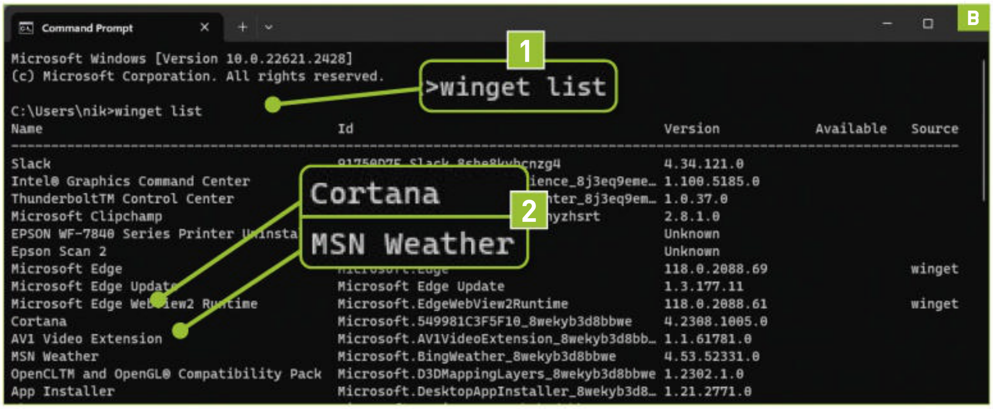
use of the corresponding public key.



```
Microsoft Windows [Version 10.0.22621.2428]
(c) Microsoft Corporation. All rights reserved.

C:\Users\nik>winget list
Name                                           Id                                    Version          Available  Source
---------------------------------------------------------------------------------------------------------------------------
Slack                                                             cnzg4              4.34.121.0
Intel® Graphics Command Center                                   ience_8j3eq9eme…   1.100.5185.0
ThunderboltTM Control Center                                      nter_8j3eq9em…     1.0.37.0
Microsoft Clipchamp                                                yzhsrt            2.8.1.0
EPSON WF-7840 Series Printer Uninsta                                                 Unknown
Epson Scan 2                                                                         Unknown
Microsoft Edge                                                                       118.0.2088.69               winget
Microsoft Edge Update                          Microsoft Edge Update                 1.3.177.11
Microsoft Edge WebView2 Runtime                Microsoft.EdgeWebView2Runtime         118.0.2088.61               winget
Cortana                                        Microsoft.549981C3F5F10_8wekyb3d8bbwe 4.2308.1005.0
AV1 Video Extension                            Microsoft.AV1VideoExtension_8wekyb3d8bb… 1.1.61781.0
MSN Weather                                    Microsoft.BingWeather_8wekyb3d8bbwe   4.53.52331.0
OpenCLTM and OpenGL® Compatibility Pack        Microsoft.D3DMappingLayers_8wekyb3d8bbwe 1.2302.1.0
App Installer                                  Microsoft.DesktopAppInstaller_8wekyb3d8… 1.21.2771.0
```

» Let's use another example to explain. Imagine that our private key was made up of the numbers 13, 1, 13, 13, and that our public key (which anyone can download) was 3, 0, 6, 6. When we compile the message we want to send, we 'sign' it by attaching our private key. Whoever receives the message can obtain our public key from a public key server and run another equation using the public and private keys as the two parts of the sum.

» The recipient already knows the answer it should generate, so they will also know, if it generates anything else, that it wasn't signed by who they expected, and should therefore be considered suspect. Let's say the answer they're looking for is the word PASS, and that the sum they'll use to get there is simply the addition of each individual digit in our public key with the corresponding digit in our private key, which was used to sign the message. It would work like this: [**Table 1**] .

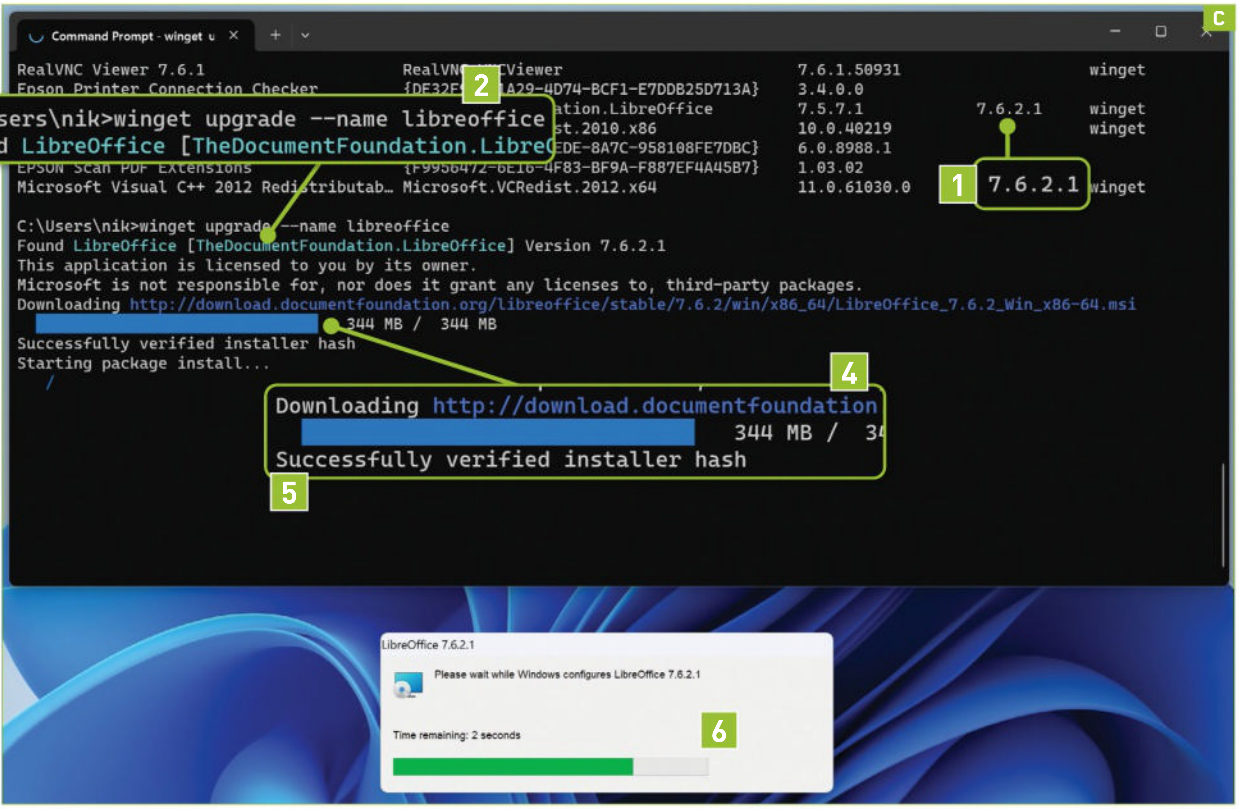
» This gives us PASS. Now imagine that someone faked our message and applied a different private key because they didn't have access to our private key and don't know what the outcome of the sum should be. Rather than 13, 1, 13, 13, they used 3, 1, 3, 6. Combining this with our public key would deliver the following: [**Table 2**] .

» This time, only one of the resulting letters is correct—the A—and the output of the equation is FAIL, rather than PASS. The person performing this sum to check the archive would immediately know that it didn't originate from its official source. Package managers can perform these checks on your behalf, so you can feel confident they haven't been tampered with since they were compiled by the developer. Or, to use more technical language, you can be sure of both their authenticity and their integrity.

2

DOWNLOAD WINGET AND RUN IT FROM COMMAND PROMPT

Microsoft's package manager, WinGet, is available for Windows 10 and 11. If you're running Windows 10 version 1709 or later (released in October 2017), you probably have it already, but you can check by opening its Microsoft Store page at tinyurl.com/ypubfu62. If there's no button to get it, you should have everything you need. If there's an option to update or install it, then do so.


C
1
7.6.2.1
2
C:\Users\nik>winget upgrade --name libreoffice
Found LibreOffice [TheDocumentFoundation.Libre
3
4
Downloading http://download.documentfoundation
344 MB / 34
Successfully verified installer hash
5
6

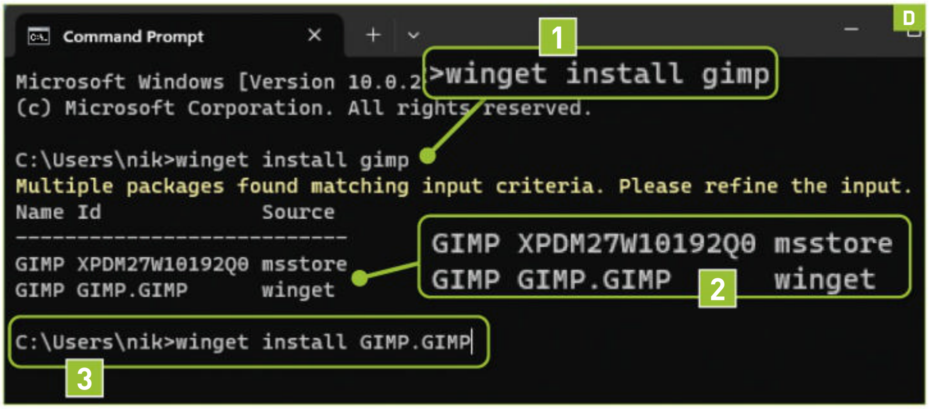
```
RealVNC Viewer 7.6.1                          RealVNC  CViewer                         7.6.1.50931                winget
                                              {DE32F   1A29-4D74-BCF1-E7DDB25D713A}    3.4.0.0
                                                       ation.LibreOffice               7.5.7.1         7.6.2.1    winget
                                                       st.2010.x86                     10.0.40219                 winget
                                                       EDE-8A7C-958108FE7DBC}          6.0.8988.1
                                              {F9956472-6E16-4F83-BF9A-F887EF4A45B7}   1.03.02
Microsoft Visual C++ 2012 Redistributab…      Microsoft.VCRedist.2012.x64              11.0.61030.0               winget

C:\Users\nik>winget upgrade --name libreoffice
Found LibreOffice [TheDocumentFoundation.LibreOffice] Version 7.6.2.1
This application is licensed to you by its owner.
Microsoft is not responsible for, nor does it grant any licenses to, third-party packages.
Downloading http://download.documentfoundation.org/libreoffice/stable/7.6.2/win/x86_64/LibreOffice_7.6.2_Win_x86-64.msi
                                  344 MB /  344 MB
Successfully verified installer hash
Starting package install...
  /
```

LibreOffice 7.6.2.1

Please wait while Windows configures LibreOffice 7.6.2.1

Time remaining: 2 seconds



```
Microsoft Windows [Version 10.0.2
(c) Microsoft Corporation. All rights reserved.

C:\Users\nik>winget install gimp
Multiple packages found matching input criteria. Please refine the input.
Name Id                  Source
---------------------------
GIMP XPDM27W10192Q0 msstore
GIMP GIMP.GIMP       winget

C:\Users\nik>winget install GIMP.GIMP
```

```
>winget install gimp
```

```
GIMP XPDM27W10192Q0 msstore
GIMP GIMP.GIMP       winget
```

» WinGet runs via the Command Prompt, so search for and open it on your Windows machine. Now, type winget list [**Image B1**] and press Enter. After a few seconds, it will show all the programs installed on your PC, some of which—like Cortana or MSN Weather [**Image B2**]—are built into the operating system.

3

UPDATE SOFTWARE WITH WINGET

Notice that two of the columns in our screenshot left are for Version and Available. Numbers in the Version column show which edition of a particular program is installed on your machine, while Available lists the most recent build that you could install if you chose.

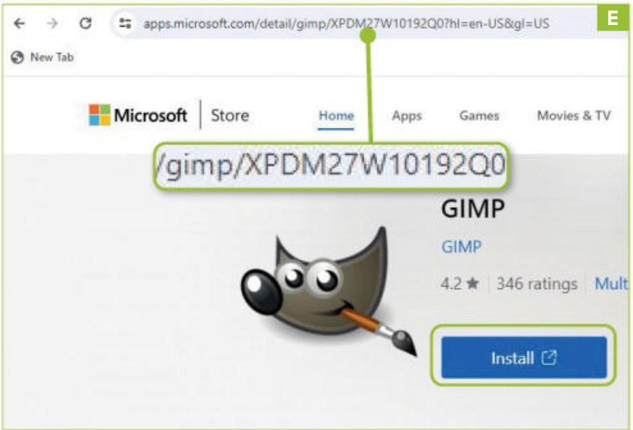
» Nothing appears in the Available column in our screenshot because all the packages are up to date. However, if we scroll to the bottom, where LibreOffice appears, you can see that while our PC is running version 7.5.7.1, the most recent release is 7.6.2.1 [**Image C1**]. Time for an update.

» We could manually download the update, which isn't difficult with LibreOffice because it's a safe, mainstream program at a recognizable URL (www.libreoffice.org). However, that might not be the case for other programs. So, you can delegate responsibility for updating the software to WinGet itself. In this case, we'll save ourselves a trip to the browser by typing winget upgrade --name libreoffice [**Image C2**] and pressing enter.

» WinGet will look up the most recent release [**Image C3**] and check that you're licensed to use it. It downloads the installer from its location, which is shown in the deep blue text [**Image C4**]. The blue bar below this tracks the progress of the download.

» The line below the bar confirms that WinGet 'Successfully verified installer hash' [**Image C5**]. This was the point where it checked that what it had downloaded was an unchanged version of the file originally uploaded by the developer. A 'hash' is the outcome of the equation that we discussed earlier, being a long number that is generated by running the contents of the download through an equation.

» Having verified the download, WinGet launched the installer running below Command Prompt [**Image C6**]. This removed the old version of LibreOffice and installed its more recent replacement, before returning us to the Command Prompt, which reported that the process had completed. At no point did we manually download the installer, and we didn't need to work out whether the downloaded file was genuine, which made the process more secure.



© MICROSOFT

4

INSTALL NEW SOFTWARE WITH WINGET

You can also use WinGet to install programs from scratch, not just update them. Let's say you want to install the free photo-editing software GIMP. Logically, you'd type winget install gimp [**Image D1**]. However, this returns two results [**Image D2**] , and WinGet needs to know which one you'd like to install.

» The first of these is available from the Microsoft Store, and we can verify that it's the program we want by typing microsoft store gimp into a search engine. The file name shown for the first option (beginning with 'XPD') matches the code at the end of the Store address in the browser address bar (pictured above).

» However, we'll install the second option, which the Source column tells us is available from WinGet itself. To do this, we'll modify the typed command to read winget install GIMP.GIMP [**Image D3**]. Once again, this starts the process of downloading the installer (from www.gimp.org this time), checking that it is licensed for use on our machine and hasn't been tampered with—and running it.

5

REMOVE PROGRAMS USING WINGET

So far, you've installed and updated software with WinGet, but you can also use it to uninstall programs. To remove GIMP from your PC, you'd use the very logical winget uninstall GIMP and press Enter. This time there's no question over what to do, as there was when installing GIMP [**Image E**], because there's only one version of the program installed on your PC.

» Be careful when removing programs this way. Unless they use an installer that you need to click through as part of the removal process, they can be deleted from your system without further confirmation. ⏻

HOW I USE PACKAGE MANAGERS

I use package managers when downloading in Windows, but the method is similar on my Linux machines. As my version of Linux is based on an operating system called Debian, it uses the APT (Advanced Package Tool), which responds to commands familiar to anyone using WinGet. For example, apt install libreoffice installs LibreOffice, while apt upgrade updates every program on my PC.

LAB NOTES

JEREMY LAIRD, CONTRIBUTOR

Yet another GPU shortage

This time, it's political

JUST WHEN YOU THOUGHT the GPU market had returned to normal, the US government creates another GPU shortage. Restrictions have been placed on Nvidia's RTX 4090, notionally preventing export to China on the basis that the GPU is so powerful, it may be useful for AI research and development. That had the impact of seeing more RTX 4090s flooding into China before the ban.

Even with the ban live, there are reports of RTX 4090s being stockpiled in countries bordering China. All of that underlines that the move is more about politics and optics. If the RTX 4090 is freely available across most of the world, China finds the RTX 4090 useful in its AI quest, and is suitably motivated, the idea that the export ban is going to have much impact is slightly risible.

Things are arguably different with dedicated AI chips like Nvidia's H100, which are more expensive, can't be snapped up by market stall traders, and are easier to track. But a gaming card available at a low cost on every online outlet? Hardly.

Speaking of relatively low costs, the impact of the inevitable run on 4090s has had the opposite effect. That's unfortunate, given it's only recently that the graphics card market has returned to something resembling normality. It's particularly frustrating with regard the 4090, because I have the sense that Nvidia underpriced the card. Yeah, an underpriced $1,599 GPU.

I say that because, of all the RTX 40 series GPUs, the 4090 got the smallest price bump over the previous generation, so you get more frames per dollar—at the official MSRP, at least—from an RTX 4090 than the likes of the RTX 4080 or RTX 4070 Ti. That makes no sense.

My worry is that price spikes on the RTX 4090 will encourage Nvidia to see the error of its ways with the 4090 and price its successor higher. If that hardly seems like a problem for most gamers, who weren't buying a 4090 or 5090 whether they were priced at $1,599 or $2,599, the problem is that a pricier 5090 creates space in Nvidia's lineup to push a 5080 even higher. That cascades down the product stack, and everything ends up more expensive. I hope I'm wrong about this, but I am a bit worried.

Weird to say it, but the RTX 4090's $1,599 MSRP is almost too cheap.

© NVIDIA

ZAK STOREY

Contributor

Whether you go in for Black Friday or not, after a few years of pandemic pain, supply chain problems, and market weirdness, this year's sales were set to be a test of PC hardware pricing. In the event, it was mostly good news.

By that, I mean there were some decent deals. Slightly frustratingly, many of the best were in the more mainstream consumer market rather than specifically PC hardware. If you wanted a cheap OLED TV, you were in luck. Still, I spotted a 32-inch IPS Acer 4K monitor with 144Hz refresh, and even USB-C with power delivery for just under $400.

M.2 SSDs were so cheap, they were almost giving them away. GPUs didn't get the same treatment. Still, just about every major new graphics chipset, bar the RTX 4090, could be had at least a little under MSRP.

My favorite deal was a last-gen Razer Blade 14. I like most things about Razer's laptops, apart from their prices, but you could snag the outgoing Blade 14, fitted with the then range-topping RTX 3080 Ti mobile GPU, for $1,799. That same laptop a year ago had an MSRP of $3,499. For $1,799, it's a really nice proposition.

While the RTX 3080 Ti is a last-gen GPU, it's faster than Nvidia's new RTX 40 mobile graphics chips up to and including the RTX 4070. The Blade 14 with an RTX 4070 is around $2,700 for slightly lower gaming performance than the RTX 3080 Ti.

Building your own 'board isn't cheap, but it is darned satisfying.

Editor's Pick: Ducky ProjectD Outlaw65

Construct your own keyboard

EVER WANTED to build your own keyboard? Get a load of the Ducky ProjectD Outlaw65. It comprises a compact kit with nearly all of the pieces required to build a mechanical keyboard from scratch and a guarantee that every piece will fit together. You need only provide switches and keycaps, which makes sense given how those are subject to personal preference.

The Ducky ProjectD Outlaw65 isn't cheap at $299, so why might you want to build your own keyboard when you can pay someone less for one already made? If you're asking rather than already convinced on the idea, it's a hard sell. Beyond an opportunity to lube up all your stabilizers and switches before putting them inside your keyboard, or the option to customize often inaccessible layers, you mostly need to be in it for the love of the game.

Assembly is easy if you abide by the instructions. It's a little time-consuming, and will take a couple of hours at a leisurely pace, but in theory that's all part of the experience. You start by building the base for the keyboard, mostly comprised of weighty sandblasted aluminum. First the adjustable feet, then the surround, which helps hold in the PCB and other important components. Even though this is a 65 percent keyboard and lacking some keys you'd usually find on a full-size unit, this is one of the heaviest keyboards out there.

Next, prep the PCB by lubing up the stabilizers, which improves the typing experience and makes for a very smooth actuation of the larger keys, using the included lube and a tiny brush. You only need a small amount of the lubricant for the stabilizers, so you could spread it over a pack of switches as well.

Now for the base plate. This is what you might call a tray mount, and there are a couple of options in the pack to choose from. There's a black FR4 with gold trim or a white POM option. These feel and sound different, which matters if you're deep into this mechanical keyboard-building thing.

A couple of spacers are required before slotting the sound-dampening foam between it and the PCB, and screwing it down. Once that's sorted, you attach the USB connector to the PCB, slot the innards into the outer metal frame, screw everything down, and you've pretty much made a mechanical keyboard from scratch—except for the switches and caps, which is both the most repetitive and familiar job for mechanical keyboard fans.

The only possible issue is the row of keys down the right-hand side. The del, page up, page down, and end keys are usually spread across two horizontal rows on a normal layout board, yet here they're across four horizontal rows. That means these keys might not stand flush with others in the same row due to the key profile.

Still, with the whole keyboard together at last, you can appreciate the board for what it is. It's one of the nicest compact boards around in terms of the tactile typing feedback—the rock-solid construction and sheer weight see to that. Admittedly, some of that will depend on the switches and caps, but the elements that Ducky is directly responsible for are excellent.

As a way to build a keyboard without the planning stage to slow you down, Ducky has delivered a superb kit. The $299 it will set you back is a little steep given that it comes without caps or switches. Nobody said building your own mechanical keyboard was cheap, easy, or necessary, but I'll be damned if it isn't satisfying. **–JL**

$299, www.duckychannel.com.tw

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Reviewed...

74 Asus ROG Maximus Z790 Dark Hero

76 Asus TUF Gaming GeForce RTX 4090 OC

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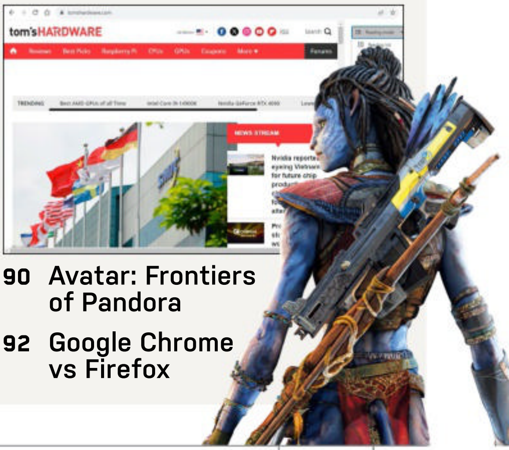

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MAXIMUS DARK HERO
SUPREME FX
REPUBLIC OF GAMERS
ROG

It's less about overclocking, and more about clocking in extra overtime…

Asus ROG Maximus Z790 Dark Hero

A dollar too far?

THIS IS A $700 motherboard. $700 of PCB and interconnects. For context, that's $125 more than an Intel Core i9-14900K, or the exact cost of an RTX 4070. Crazy.

What's alarming about that fact is that it's not even close to being the most expensive Z790 board out there. Nope—that's a title reserved for MSI's eye-watering Godlike and Godlike Max boards, which both clock in at an incredible $1,200. In fact, there's a total of four other boards that pip the Dark Hero on the price front. Why, all of a sudden, do we have motherboard lines landing with prices akin to that of a first-time car? And better yet, who's buying them?

Many years back with the launch of the X570 chipset, we berated Asus for the steady increase in price of the Hero line. Premium gaming motherboards started at $150, then they became $230. By the time that one had landed, it was up to $360. Now we're at twice that? Yes, some of the tech has become more complex. PCIe 5.0 does add additional cost and engineering to the manufacturing process, sure, but come on, this is ridiculous.

So what exactly do you get for $700 of hard cash? Well, that is the Dark Hero's saving grace. Aside from the rather dubious-looking ROG logo illuminating that mirrored rear I/O cover, you get support for up to 5x M.2 slots (1x PCIe 5.0, 4x PCIe 4.0), support for 2x PCIe 5.0 devices, a 20+1+2 power stage design and enough I/O to make you weak at the knees, including an Intel 2.5Gb Ethernet Port, six USB 10 Gbps ports, WiFi 7 connectivity, and two Thunderbolt 4 ports. Honestly, it's a bit of a beast.

The Dark Hero also comes with some impressive embedded cooling for those power phases, along with plenty of reinforcing metal 'armor' across the lot. There's also a number of nice little build features on here, including a quick-release button for the top-most PCIe slot (located just right of the DIMM slots) to save you from fumbling around with screwdrivers trying to release graphics cards, and Asus's new staple Q-latch for its M.2 devices (although MSI does have something similar to this as well).

It's an impressive product, and at first glance out of the box (if you haven't looked at the price) it's stunning to look at: weighty, premium, and enough glamor to make even the most enthusiastic of system builders happy.

As far as performance is concerned, the Dark Hero holds its own. In our testing, we saw impressively low temperatures and power-draw, particularly compared against the likes of MSI's Z790 Ace Max. With load temperatures being 7 C lower, and load power draw 8W lower too. Memory bandwidth and SSD performance trounced the competition too—however, the Dark Hero did fall in 1080p gaming, scoring consistently lower in both *Total War: Warhammer III* and *Horizon Zero Dawn*. From outward appearances, that looks to be down to how each board is handling the frequencies and voltages it sends to the CPU. The MSI board does seem to be pumping more juice into it under-load, and this is leading to higher package temperatures and power draw. Conversely, it is also giving the single-core performance a slight edge, helping it pip the Dark Hero in our gaming suite.

Honestly, the Z790 Dark Hero is a hard sell. Considering you can pick something up like the Strix Z790-E Gaming WiFi, with very similar connectivity and power-phase solutions, that still looks stellar for $300 less. Does it perform well? Yes. Does it look good? Also yes, but it's just so hard to get past that price. This isn't a groundbreaking GPU with years of research and development behind it breaking down transistor size another few nanometers; this is a motherboard, and for better or worse, the value added by WiFi 7 or extra USB ports just isn't worth that price. –**ZAK STOREY**

VERDICT **7**

Asus ROG Maximus Z790 Dark Hero

⊞ **DOWN PAYMENT** Strong performer in connectivity tasks; Clean design; Solid software in AISuite; Top-tier BIOS and good firmware support; Cooler than the competition.

⊟ **DESTITUTE** Price is through the roof; RGB could be better.

$699 www.asus.com

BENCHMARKS

	Asus ROG Maximus Z790 Dark Hero	MSI MEG Z790 Ace Max
GeekBench Single / Multi (index)	2,793 / 17,560	**2,797** / **17,646**
CineBench R23 Single / Multi (Index)	1,948 / **23,109**	**1,960** / 22,890
CrystalDisk Mark Sequential Q32T1 (MB/s)	7,131 / **6,113**	**7,133** / 5,987
CrystalDisk Mark Random 4K Q1T1 (MB/s)	**89.38** / **329.90**	79.93 / 293.29
SiSoftSandra Memory Bandwidth (GB/s)	**83.48**	76.86
SiSoftSandra Memory Latency (ns)	**72.2**	73.6
CPU / GPU Temperature - Desktop @ Load (C)	**83** / **63**	90 / 64
CPU & GPU Power Draw @ Load (watts)	**476.66**	483.03
3DMark: Fire Strike (Index)	**47,196**	47,162
Horizon Zero Dawn	220	**227**
Total War: Warhammer III	209	**218**
Cyberpunk 2077 RTX	**125**	**125**

Best scores in bold. Our test bed consists of an Intel Core i5-14600K, 32GB of Corsair Dominator Titanium @ 7200, an Nvidia GeForce RTX 4080, Corsair H150i AIO, and an Adata Legend 960 Max PCIe 4.0 SSD. All gaming tests were performed at 1080p, on the highest preset. XMP is enabled.

SPECIFICATIONS

Chipset/Socket	Z790 / LGA1700
Max Memory Support	192GB DDR5 @ 8000+
Storage Support	5x M.2 Slots (1x 5.0x4 and 4x 4.0x4), 4x SATA 6Gb/s
PCIe Support	2x PCIe 5.0 x16 (x8x8)
Form Factor	ATX, 12 x 9.6-inches
Rear I/O	2x Thunderbolt 4 Type C, 6x USB 10Gbps (5x Type A, 1x Type C), 4x USB 5Gbps Ports (4x Type A), 1x HDMI port, 1x WiFi 7 Antennace, 1x Intel 2.5Gb Port, 5.1 Audio + Iotical S/PDIF Out, BIOS FlashBack, Clear CMOS

Asus TUF Gaming GeForce RTX 4090 OC

What is going on with RTX 4090 prices?

THE ASUS TUF Gaming RTX 4090 OC Edition is a stripped-down version of the flagship ROG Strix RTX 4090. That means the same Ada Lovelace streaming multiprocessors, the same 4th Gen Tensor Cores, the same 3rd Gen RT Cores—you get the idea.

You also get a trio of familiar but redesigned Axial-tech fans, though this board lacks some of the extra flashy stylings from the flagship card. Still, with so-called military-grade capacitors rated for 20,000 hours at 105 degrees Celsius, the TUF Gaming RTX 4090 OC is designed to perform under load and last for years of gaming, which is handy given the current price of RTX 4090s.

The design of the Asus TUF Gaming RTX 4090 OC GPU is understated, but fitting for most gaming PC builds. The metal back plate is stunning, and so is the metal shroud—you'll struggle to find any plastic here. The entire package feels premium and well built, but all this metal does make it a little heavy, especially when looking at how small the PCB is.

The weight can at least be addressed with the included stand. This is an ingenious accessory that can be adjusted with a small wheel. Should you extract the adjustable center tube out, you'll be greeted by a small Philips screwdriver. The bottom of the stand is magnetic, allowing it to 'stick' to a metal chassis.

Like previous generation NVIDIA cards, Asus makes good use of a passthrough for the large fin array. For cooling, Asus uses three 104mm Axial-tech fans with dual-ball bearings. They're capable of spinning up to 2,260rpm, and can push through 63 cubic feet of air per minute.

STEPPING UP PERFORMANCE

To power the Asus TUF Gaming RTX 4090, you'll need to use the included 8-pin splitter, which combines four 8-pin PCIe power inputs for a single 12-pin GPU connection. With the card itself being able to pull upwards of 500W alone, having a reliable power supply is a must. 850W is considered the minimum for an Intel Core i5 or AMD Ryzen 5 PC build, but we'd recommend 1000W to be on the safe side and then 1200W for an Intel Core i9 or AMD Ryzen 9 processor

The 4090 as a GPU has been around for about a year now, but it's worth recalling what a huge leap it was at launch. With Ada Lovelace, NVIDIA increased the CUDA core count by more than 50 percent, from 10,496 to a whopping 16,384. Streaming processors are up from 82 to 128, tensor cores have almost doubled from 328 to 512, and ray tracing cores have been boosted from 82 to 128. The same 24GB of GDDR6X is present with a 384-bit memory bus. All this results in considerable performance gains.

In fact, the RTX 4090 really has no competition. That didn't change when AMD brought out its own flagship GPU in the Radeon RX 7900 XTX, so the RTX 4090 lives on in a class of its own. For a while you could actually get 4090s at Nvidia's $1,599 MSRP. That looked like a steal compared to the outgoing RTX 3090 which officially had an MSRP of $1,499, but typically sold for far more thanks to the influence of external factors, including cryptocurrency mining.

More recently, the US government has imposed restrictions on exporting an RTX 4090 GPU to China, which in turn has caused something of a run on the GPUs, partly from inside China to snap up as many 4090s as possible before the ban went live and then in countries bordering China for what appears to be a stockpiling of GPUs with an intent to get them across the border somehow, some way.

Whatever, the net result has been a spike in RTX 4090 values and in terms of this precise model that translates into a price of $2,759 on Newegg as these words are typed. As good a card as this is, that really is far too much. **–RICH EDMONDS**

VERDICT

8

Asus TUF Gaming GeForce RTX 4090 OC

➕ **SCARY GOOD** Easily the fastest GPU around; Well engineered PCB and cooling.

➖ **PLAIN OLD SCARY** RTX 4090 prices have become rather silly of late.

$2,759, www.asus.com

BENCHMARKS

	Asus TUF Gaming GeForce RTX 4090 OC	Nvidia RTX 4090	Nvidia RTX 4080
3DMark TimeSpy Extreme (pts)	**16,911**	16,810	13,193
Cyberpunk RT 4K (fps)	**50**	**50**	37
Metro Exodus Enhanced (fps)	**78**	77	54
Total War: Warhammer III (fps)	**101**	99	74
Far Cry 6 (fps)	**135**	134	108

Best scores are in bold.

SPECIFICATIONS

Architecture	AD102
Manufacturing process	TSMC 4N
Transistors	76.3 billion
Tensor cores	512
CUDA cores	16,384
RT cores	128
Boost clock speeds	2565 MHz (OC: 2595 MHz)
Memory	24GB GDDR6X
Memory interface	384-bit
TDP	450W

GEFORCE RTX
TUF GAMING
MISSION 25°07'37.0"N

It's hard to say what's scarier: this board's mammoth proportions, or recent RTX 4090 prices.

Lenovo LOQ 15APH8

A rare miss from one of the best laptop brands

THE GAMING LAPTOP space is complex. It's full of different specs, price points, and brand names, so it can be tough to see where a new machine fits. But Lenovo's LOQ family notionally offers a pretty clear proposition.

Where the company's Legion machines are all solid chassis, high-level pricing, and spec sheets, the Lenovo LOQ range would be cheaper, less premium, and come with a lower level of hardware for a bargain price. But the Lenovo LOQ 15-inch range, championed here by a system comprising an AMD CPU and Nvidia RTX 4050 GPU, doesn't actually make a lot of sense at full retail rice—not in a world where you can often bag the Lenovo Legion Slim 5, with the same CPU and GPU combination, for around $100 more.

And yet they're very different in terms of overall quality. The Legion Slim isn't exactly slim, but it's a really nice chassis, with a good screen, and efficient cooling. The LOQ, on the other hand, suffers from old-fashioned chonk. It's not super-bloaty, and actually looks and feels tolerably premium. There are affordable Gigabyte and MSI machines that really do seem way cheaper when you flip open the lids. But compared with its similarly priced sibling, the build quality of the LOQ is quite different—and quite plasticky. Still, it's an effective chassis, able to keep the 95W RTX 4050 GPU running at peak power and therefore mighty close to the gaming performance of a 75W RTX 4060.

On the 1080p screen, that means relatively playable frame rates in the latest games. *Metro Exodus Enhanced* delivers 60fps, while *Hitman* and *Horizon Zero Dawn* will net you 100fps and beyond. *Cyberpunk 2077* is the test that highlights where the actual hardware difference is between the RTX 4050 and RTX 4060, as machines equipped with the latter do outpace the LOQ.

Where this Lenovo shines, however, is in the CPU tests. Despite a lowly 8GB of RAM—legitimately not enough in today's market, or for this amount of money—the AMD Ryzen 7 7840HS is an outstanding mobile chip, and that shows in the relative benchmarks. Compared with either an Intel Core i7 or Core i5 chip in competing machines, the AMD processor again shows that Team Red has got things sewn up in mobile.

But it's not just the Zen 4 cores that make this chip a good laptop part. It's also got the full Radeon 780M integrated graphics. That's the same iGPU that powers the best gaming handhelds today, and can deliver genuine 1080p gaming frame rates, though not here. You'd hope to be able to disable the RTX 4050 and use the integrated Radeon core to provide a bump to the battery life, but the frame rates are down on the Framework AMD mainboard, which uses the same 780M GPU, and below the handheld gaming PCs. The problem is that paucity of memory, which blows the iGPU performance.

That's a pity, because the battery life really could do with boosting. This machine keels over after just 45 minutes in the PCMark 10 gaming battery life test. The screen is another disappointment. Dim and dull, the colors are incredibly subdued, and it just doesn't feel that clear reading text on the desktop, either. This really is where the budget feel of the LOQ range bites hard.

We've actually spotted this laptop on sale for $750, at which point it is admittedly a bit more compelling. And it does have Lenovo DNA, including an excellent keyboard, with full numpad and a really nice typing feel. Oh, and there are a couple of spare SSD slots inside, DDR5 RAM upgrades aren't as expensive as they once where, and Lenovo has actually made it relatively easy to get inside the chassis with just a cross head screwdriver. But this remains a rare miss for a company that has been nailing its recent laptop releases. The LOQ isn't getting our recommendation for now. **–DAVE JAMES**

VERDICT

6

Lenovo LOQ 15APH8

➕ POSITIVELY LOQUACIOUS Fantastic CPU; Very nice keyboard.

➖ TALKIN' CRAP 8GB of RAM is feeble; Low-quality display.

$1,100, www.lenovo.com

BENCHMARKS

	Lenovo LOQ 15APH8 (RTX 4050)	MSI Cyborg 15 (RTX 4060)	Gigabyte G5 HF (RTX 4060)
Cyberpunk 1080p (fps)	21	38	**53**
F1 2022 1080p (fps)	**53**	41	52
Metro Exodus 1080p (fps)	**60**	46	57
x264 video encoding (fps)	**50**	39	41
PCMark gaming battery life (m:s)	45:00	58:00	**62:00**

Best scores are in bold.

SPECIFICATIONS

CPU	AMD Ryzen 7 7840HS
GPU	Nvidia RTX 4050 (95W)
RAM	8GB DDR5-5600
Storage	512GB SSD
Screen	15-inch IPS @144Hz
Native resolution	1920 x 1080
Connectivity	WiFi 6, Bluetooth 5.1, 1x USB-A 2.0, 2x USB-A 3.2 Gen 2, 1x USB-C 3.2, Ethernet, HDMI 2.1, 3.5mm audio

© UNSPLASH

Not enough RAM, but plenty of CPU power.

Asus ROG Strix Scar 16

If there's such a thing as a value $2,500 gaming laptop, this is it

WITH BOTH INTEL and Nvidia's latest mobile chips, plus a price tag of $2,549, Asus ROG Strix Scar 16 generates very high levels of expectation. That doesn't just apply to gaming performance, but to the general user experience. It's all very well stuffing in an RTX 4080 and Core i9 13980HX, but how well engineered and optimized is this thing?

Before we get into the numbers, the Scar 16 is off to a good start with its aesthetic. There's an industrial flair to the design without being edgy or over styled. It's reminiscent of the resurgent retro console trend, with a subtle translucent plastic RGB strip around the chassis edge and front.

The Scar 16 is a thick old thing, raising hopes of a mechanical keyboard under the lid. No such luck, sadly, though the chiclet board has a pleasantly tactile bounce. Along those beefy edges, you're looking at a couple of USB 3.2 Gen 2 Type-A ports on one side, and a pair of USB Type-C ports on the other, one Thunderbolt 4 with DisplayPort, the other for display and/or power delivery to peripherals. There's an HDMI 2.1 port as well as 2.5G ethernet. In other words, high-spec connectivity isn't going to be a problem.

As for performance, with the Asus ROG Strix Scar 16 packing a full-spec 175W RTX 4080 GPU, the gaming performance numbers blow straight past some other current-gen laptops we've tested, even ones packing the RTX 4090 in its 150W form. In *Cyberpunk 2077*, for example, the Scar 16 manages 57 fps averages at 1080p against the Asus Zephyrus M16's 60 fps, even in Ultra Ray Tracing mode.

The Strix's 'Nebula' screen, meanwhile, sports a 16:10 aspect ratio that really pays off when you switch things up for a work session, though movies and cutscenes in games may end up sandwiched between black bars. This 240Hz Mini-LED panel handles HDR well, the smaller panel size making for more tightly packed dimming zones than a desktop monitor, which allows for superior lighting precision—a cherry atop a fine gaming laptop, indeed.

The other major highlight is, of course, the Intel Core i9 13980HX. A CPU like this gives the Strix Scar 16 a leg up against some of the $4,000 laptops of this generation. It puts even the $4,000 Asus Zephyrus M16's i9 13900H to shame when it comes to video encoding, and although its multi-core performance falls behind the $5,300 MSI Titan's i9 13950HX in rendering benchmarks, it's single-core you're looking at for gaming. There, the Strix Scar stands with the best.

All that power comes at a price, however and it means that while the Strix Scar 16's 80-minute battery life sits in the middle compared to other gaming laptops of its class, it's still not at the level we want from a portable device. It also runs very hot, the CPU and GPU hitting 105°C and 83°C respectively under load. There's some serious coil whine coming from under the hood when you boot up a game, too. It's mostly drowned out by the laptop's fans, but it can sound quite concerning if you're not used to these kinds of common hardware noises.

The one obvious exception to all this performance prowess is storage. The 3DMark storage index score comes in lower than the less expensive Legion Pro 7i. Pair the 103ns against the Legion's speedy 58ns, and *Final Fantasy XIV Endwalker* load times of 11.236 seconds against a tasty nine seconds, there's a lot to be desired in the storage department.

That aside, there's an awful lot to like about this Asus machine. While it's not exactly cheap, you could still spend dramatically more without any real benefit to gaming performance. In that sense, what you're looking at is pretty much peak mobile gaming, at least until Nvidia comes up with its next mobile uberchip. **–KATIE WICKENS**

VERDICT

8

Asus ROG Strix Scar 16

+ POWER HOUSE Fantastic components; Reasonable price; Lovely screen.

− HOUSE OF CARDS Disappointing storage performance; Runs very hot.

$2,549, www.asus.com

BENCHMARKS

	Asus ROG Strix Scar 16 (RTX 4080 175W)	Lenovo Legion Pro 7i (RTX 4080 150W)	Asus Zephyrus M16 (RTX 4090 175W)	MSI Titan (RTX 4090 175W)
Cyberpunk 2077 1440p RT (fps)	39	39	39	**47**
F1 22 1440p RT (fps)	65	72	73	**76**
Horizon Zero Dawn 1080p (fps)	144	147	133	**162**
3DMark Storage (pts)	1,750	**3,074**	2,426	2,374
Cinebench R23 multithread	28,845	29,276	19,689	**31,945**

Best scores are in bold.

SPECIFICATIONS

CPU	Intel Core i9 13980HX
Graphics	RTX 4080 (175W)
RAM	16GB DDR5-4800
Display	16-inch ROG Nebula HDR, 240Hz, 3ms
Storage	1TB NVMe SSD
Ports/ Connectivity	1x 3.5mm Combo Audio Jack. 1x HDMI 2.1 FRL, 1x USB 3.2 Gen 2 Type-C for display / power delivery, 2x USB 3.2 Gen 2 Type-A, 1x 2.5G LAN port, 1x Thunderbolt 4 DisplayPort with G-SYNC
Weight	2.50kg / 5.51lbs
Size	13.94 x 10.39 x 1.20 inches /35.4 x 26.4 x 3.04 cm

© UNSPLASH

The Strix Scar delivers fantastic performance and a lovely screen for a relatively reasonable price.

Asus ZenScreen GO MB16AWP

A take-anywhere monitor that's a surprisingly complete package

PORTABLE MONITORS like this aren't usually *Maximum PC*'s vibe. It's not 4K, doesn't have a 500Hz refresh rate, isn't ultrawide, and doesn't measure 40 inches across the diagonal. The ZenScreen Go is modest of proportion, reasonable of brightness, and apparently humble of spec, but makes connections like a LinkedIn addict, and will work anywhere.

That's why it's here, among the fast, huge, and RGB-festooned. The ZenScreen is just so useful. In the time we've spent with it, we've used it as an emergency monitor for a desktop tower, wirelessly connected it to a laptop and a phone, wired it up to an iPad, seriously considered attaching a streaming stick to its HDMI port through an adapter, and marveled at the way you can supply it with both power and a video signal with a single USB-C cable. Convenience is an underrated commodity in an industry that still hungers for more power and cables.

As a 15.6-inch 1080p IPS screen, the ZenScreen Go is slightly behind where laptops are at right now, but as a second screen for travel, it's ideal. The ZenScreen Go's design means it's absolutely flat for slipping into bags designed for other flat things, and a useful stand folds out from the back, so you don't need to worry about buying a stand or case (there's also a connector on the back that screws onto a standard camera tripod). There are two buttons on the front: one for power, and the other a disguised joystick for navigating the on-screen menu. This comes into its own when switching between inputs, and when you swap to a wireless connection, a complete set of instructions appears on the screen for various classes of device.

Wireless monitor connections in Windows are a kind of magic. The monitor appears as a Wi-Fi hotspot you can connect to, and once it's hooked up somehow manages to connect back to the internet. It feels amazing, and makes us wonder why it's not more common. You don't have to use a USB-C cable to supply power all the time either, as the ZenScreen Go has a built-in battery that's good for about four hours of use. There are also USB-C ports for power and video, and a Mini HDMI that's the only annoyance here—you'll always need an adapter. Thankfully, there's one in the box.

Picture quality from the IPS panel is extremely good, with a decent viewing angle and a max brightness of 250 nits. That's not excessively bright like the newest generations of laptops, but it's enough if the screen is in a shaded room. The speakers aren't great, but will do in a pinch if you're streaming to the screen from your phone and don't have Bluetooth earphones with you.

We'd never suggest you drop $450 on something you'll never use, but if you can identify a way in which a portable monitor could improve your life in some way, then getting one with a plethora of connectivity options, a built-in stand, decent picture quality and brightness, and even some speakers makes a lot of sense. As an all-in-one solution, the ZenScreen Go takes a step beyond other portable monitors that provide only HDMI and USB-C, and that's why, despite initial questions over its utility, we've come to enjoy having it around. **–IAN EVENDEN**

VERDICT
9

Asus ZenScreen GO MB16AWP

+ ZENSCREEN HO! Sharp 1080p panel; Lots of connectivity; Speakers.

− ZENSCREEN NO! No bigger than your laptop screen; Not touch sensitive.

$449, www.asus.com

SPECIFICATIONS

Screen	15.6in 60Hz 1080p IPS
Connectivity	Wi-Fi, 1x Mini-HDMI, 2x USB-C (DisplayPort 1.2 Alt Mode), 1x 3.5mm headphone
Speakers	2x 1W
Battery	7,800mAh
Dimensions	14.09 x 8.84 x 0.45 inches
Weight	2.4 pounds

ZenScreen Go

© UNSPLASH

The ZenScreen Go is so darned useful.

PHANTOM GAMING
PHANTOM GAMING Z790 RIPTIDE WiFi
ASRock
RIPTIDE
M.2 BLAZING
M.2 ARMOR
M.2 ARMOR
ASRock
PHANTOM GAMING SERIES
RoHS

The Z790 Riptide WiFi has features that make more expensive boards look average.

ASRock Z790 Riptide WiFi

Do you really need to spend more?

THIS LATEST Z790 refresh board is part of ASRock's Phantom Gaming lineup. At £250, it's an affordable option that comes with out-of-the-box support for Intel's 14th Gen processors, though it supports 12th and 13th Gen processors as well.

You could argue that these new Z790 motherboards are the same as their predecessors with barely a lick of paint. But if you're upgrading from a system that's a few years old, then Z790 refresh motherboards have a lot of appeal. They include the latest connectivity features, electrical refinements, and support for fast memory. And although many models have taken yet another step up in price, that doesn't apply here. The ASRock Z790 Riptide still offers a lot for your money.

It includes WiFi 7, support for DDR5-8000+ memory—something the existing non-WiFi model can't match—five M.2 slots, and eight SATA ports. Add to that PCIe 5.0 SSD support, and you've got an excellent core feature set that at least matches many more expensive motherboards. You also get an improved VRM, a refined audio section, and curiously, a rear-mounted embedded DisplayPort connector that's suitable for ASRock's 13.3-inch side panel kit.

There's a strip of RGB LEDs under the M.2 heatsink, which is very bright if you look directly at them. On top of that, you get three ARGB headers, plus another RGB header that supports 36W strips. There are seven fan headers, so it's a cooling and RGB friendly option.

Of the five M.2 slots, the primary slot supports PCIe 5.0 SSDs and comes with a reasonably high surface area heatsink that's attached via a simple screwless mechanism. That's becoming an increasingly common feature, and a welcome one at that. The other four slots support PCIe 4.0 drives, and all are covered by screw-in heatsinks. Add to that eight SATA ports, and you've got a motherboard with best-in-class storage potential. There aren't many boards at any price that support that many drives.

As for cooling and performance, the VRMs are well specced for a board at this price. It's a 16+1+1 phase design with 90a stages, which means it will handle any LGA 1700 processor. The heatsinks are relatively chunky, but they are not connected via a heatpipe and get rather hot to the touch. The rear I/O has a decent enough complement of ports. Although a 20Gbps USB port would be nice, there is a 20Gbps case header. Ethernet duties are provided by a Killer E3100G 2.5G controller, but the star of the networking show is the inclusion of WiFi 7.

But what about performance? Tested with a 14900K, this board gives decent but unexceptional performance, albeit the context is small variances in performance from one motherboard to the next.

When it comes to gaming performance, the motherboard makes little difference compared to the CPU and GPU. The Z790 Riptide WiFi won't have any problem at the heart of a gaming system, even with a 14900K and RTX 4090, as long as you have good case airflow to keep the VRM cool with that kind of combo.

Still, it did particularly well in the 3DMark storage test, and hit the full DDR5-8000 spec, as advertised. Sure, if you want 10GB LAN, a fancy OLED screen, an M.2 add-in card, or a gazillion amp VRM for LN2 overclocking, then you'll have to pay more. But for anyone looking for a solid, mature, and feature-packed budget option, it's hard to look past this. It's a class-leading LGA 1700 motherboard with an unbeatable set of features for the money and few significant shortcomings, making it another high-value offering from ASRock. **–CHRIS SZEWCZYK**

VERDICT
9

ASRock Z790 Riptide WiFi

➕ **TOTAL BARGAIN** Fab feature set for the money; Decent performance.

➖ **FALSE ECONOMY** VRM cooling could be better; Rear IO lacks full-speed USB.

$250, www.asrock.com

SPECIFICATIONS

Socket	Intel LGA 1700
CPU compatibility	Intel 12th, 13th & 14th Gen desktop processors
Form factor	ATX
Memory support	DDR5-8000(OC), up to 192GB
Storage	5x M.2, 8x SATA
USB	1x USB 3.2 Gen 2x2, 2x USB 3.2 Gen 2, 7x USB 3.1 Gen 1, 6x USB 2.0
Display	1x eDP 1.4, 1x DP 1.4, 1x HDMI 2.1
Networking	Killer E3100G 2.5G LAN, WiFi 7
Audio	Realtek ALC1220

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Nacon Revolution 5 Pro

Not one for the PS5 owners, that's for sure

THE NACON REVOLUTION 5 Pro gaming controller takes a lot of cues from the Microsoft Elite Series 2, both aesthetically and in terms of its key features. But among the two main console combatants, it's important to consider Nacon's alignment with PlayStation, as opposed to Xbox, what with its Sony-exclusive features.

We use the word 'combatants' unironically, since Nacon specifically designed it with fighting games in mind. That doesn't stop it acing all kinds of games, though there are a few things that stand in the way of a deadly combo for the Nacon R5P.

The fact the Nacon is fighting Sony's corner is made clear with the central PlayStation logo on the home button, as well as the signature face buttons and touchpad. On the back, alongside more switches than the Millennium Falcon's control panel, sits the option to physically switch between PC, PS4, and PS5 modes. It's helpful if you swap between platforms a lot, but despite this easy switch and compatibility with Sony consoles, there's something missing here.

Even with Sony backing it, software limitations around how PS5 games are coded mean the company has been unable to deliver one of the major features PlayStation 5 users expect from their controllers: vibration. Yep, the Nacon R5P simply doesn't vibrate when playing PS5 games on the PlayStation 5. It's a non-issue for PC and PS4 users, or PS5 users who only play PS4 games on their shiny new console (why?), but the lack of haptics for a console that made a big deal about haptics is a big drawback.

The Nacon R5P also refuses to pair to consoles via Bluetooth. The controller's Bluetooth 5.2 card can only be used to connect a wireless gaming headset to the controller, which means you have to go wired or plug the included dongle into the front of your console.

The Nacon Revolution 5 Pro also comes with interchangeable weights, thumbsticks, and another d-pad, just as the Elite Series 2 does. While it's missing the hot-swap paddle switches, Nacon has gone above and beyond by adding Hall effect sensors to both the triggers and sticks.

STANDOUT FEATURE

Arguably the most exciting feature, Hall sensors are a big draw. They provide a clever, contactless mechanism that not only makes the sticks and triggers pretty darn precise, but also circumvents the problem of stick drift that seems sadly inevitable with DualShock and DualSense controllers. It's clear to see the precision when you get into the software and start calibrating, and there's a satisfying resistance from both stick and trigger that doesn't come with the odd scratchy sensation that some do. That said, the Xbox Elite Series 2 also features both Hall effect triggers and sticks, so the Nacon still hasn't one-upped its Xbox alternative.

The Nacon R5P is also a lot heavier than the DualSense at 315g, even before you mess around with the included weights. The PlayStation signature trackpad Nacon has managed to jam in the middle, meanwhile, can come in handy for some games. Its sunken facade and gentle click make pressing it a satisfying experience, but it's an unnecessary feature for most gamers.

Importantly, it's not an unattractive controller. Gorgeously rounded, the RGB ring around the right thumbstick gives it a nice flair, and Nacon's use of indicator lights to let you know when you're at min/max volume, as well as what profile you have selected is great, and especially useful when accidentally switching profiles is a thing that happens a lot.

While the Nacon R5P does come with a carrying case, as expected from a controller that costs $200, it doesn't double as a portable USB Type-C powered charging station like the Elite Series 2's case. As for battery life, Nacon claims 10 hours, but the just over seven hours it puts out in real-world terms are nothing compared to the 40-plus hours that the cheaper Elite Series 2 achieves. Long story short? The durable, comfortable, and stylish Nacon Revolution 5 Pro is appealing but not actually all that well placed as a contender to the Sony DualSense Edge. **–KATIE WICKENS**

VERDICT
7

Nacon Revolution 5 Pro

+ FEELY GOOD Looks and feels good; Hall Effect sticks; Low latency.

− REALLY BAD Poor battery life; No haptics on PS5; Bluetooth limitations.

$200, www.nacongaming.com

SPECIFICATIONS

Compatibility	Windows 10, PlayStation 4, PlayStation 5
Connectivity	2.4 Wireless, Bluetooth 5.2 (simultaneous)
Ports	USB-C, 3.5mm jack
Thumbstick layout	Asymmetric
Weight	315g | 7oz

Corsair iCUE LINK Ecosystem

Single cable daisy-chaining luxury

THIS IS GOING TO BE a touch different to some of our usual reviews, as we're actually going to be evaluating a number of products from Corsair, all under one review. Yep, we're talking about Corsair's iCUE LINK PC building ecosystem. You can see our full build process involving the hardware on page 16, but that said, how does this kit fair in isolation?

iCUE LINK is a complex daisy-chaining solution designed to simplify the build process, while providing a ton of customization and top-tier build features across Corsair's new product stacks. It's early days, but the company has launched a number of products, including a range of AIOs, both with and without screens, in a multitude of different sizes, fans of course (in black and white at 140mm and 120mm variants, each with its own temperature thermistor baked in), an armada of different cable types and accessories, to get to all those hard to reach places, and more impressively, a whole array of liquid-cooling componentry, as well including everything from pump/res combos with integrated displays, to full GPU blocks and hybrid fan solutions.

It's an impressive number of products for sure, but they all come with one small caveat: the price, and boy these things aren't cheap. A quick look on Amazon or PC Part Picker, and you'll find a standard starter-kit including three 120mm fans, will set you back $160 straight out of the gate. Want a 240mm AIO to pair with that? No screen? That's another $200 on top. LCD screen version of that instead? $290. Admittedly, you do get everything you need to go with that, but it's a tough pill to swallow. Take a look at our system build this issue, and you'll see that the total iCUE LINK cost comes to $700. It isn't cheap.

There's definitely some dev cost in there. Corsair has developed its own proprietary (sigh) heavy duty, reversible connector to interconnect these devices. Each product has a port for these, or a male-to-male adapter for them, and they lock magnetically to one another. This transfers both power and data, and is an impressively rugged bit of kit.

Building with the kits generally is smooth sailing. There is some thought needed about which cable goes where, and how many devices you have on each line (spoilers, you can only have seven devices on each side of the LINK hub), but otherwise, it's a seamless process that does remove a lot of the faff involved with hooking up multiple fan and RGB headers at the end of the build process.

The big question: is that worth the cost? That's going to be a tricky one to answer. After all, most will typically build a system once, and as any hobbyist will tell you, it's fairly easy to do some simple cable management and have a real clean-looking system straight out of the gate. Then, outside of the odd cleaning session, your rig's finished.

There are some cool little features though, unsurprisingly in the RGB field. You can set up a 'time-warp' effect, where the LEDs will fire at just the right frequency to simulate a static fan, even when the blades are moving, which is pretty neat. And of course, there's all the iCUE Murals custom RGB lighting and syncing. This means that it'll sync with your Philips Hue and Nanoleaf products as well, but that's about it.

All in all, it's a clever daisy-chaining system—one of the best we've seen, with a hefty price tag. The ultimate question will be just how far will Corsair take the platform? Will we see cheaper products eventually filter down the pipeline, or full integration with cases, memory, power supplies? There's some incredible opportunities here, but it needs to be handled just right. **–ZAK STOREY**

VERDICT
7

Corsair iCUE LINK Ecosystem

+ **4TH OF JULY** Incredibly intuitive to build with; Impressive light-shows; Integrated temperature sensing on fans is very cool; A lot of product.

− **NATIONAL EGG DAY** Super pricey; More cables in starter kit would be nice; No PSU integration yet.

$55 - $410, www.corsair.com

SPECIFICATIONS

Fans	120mm / 140mm
Coolers	240mm / 280mm / 360mm / 420mm
Colorways	Black / White
Power Required	1x 6pin PCIe power
Motherboard Connectivity	1x Internal USB Header, 1x CPU fan tachometer
Maximum Number of Devices	14 per Link Hub, 7 per line
Software Required	iCUE v5.0 or above

Creative Zen Hybrid Pro SXFI

Well-rounded headset offering great value

THOSE OF YOU who've been using PCs long enough will no doubt recognize the name Creative. The company's dedicated sound cards were a common addition to many a PC, back before it was a feature integrated into your motherboard. My first PC had one 25 years ago, and honestly it was quite a surprise to hear that the company was still going when I got the call to review its latest PC headphones.

Thankfully, it was a pleasant surprise, given how good the company's latest lineup is. The key detail is the pricing—this Zen Hybrid Pro SXFI model goes for $150, and includes every feature any gamer, office worker, or mobile user would ever want from a headset. That includes wireless capability, active noise cancellation, 80+ hour battery life, a detachable microphone, virtual surround sound, and a bunch of gaming presets to enhance popular titles. It's comprehensive, to say the least.

The look of the headphones closely resembles that of lifestyle models from the likes of Sony and Bose—they're clearly designed to be worn on the bus or plane. Adding to that aesthetic is the fact that they fold up to be stored in a bag, although sadly no carry case is included in the box. They also charge via USB-C, and weigh just 282g, much like other popular cans.

These headphones are light and comfortable, with a soft pleather material over the ears. My only gripe was that the ear cups weren't quite big enough to form a snug fit over my clearly larger-than-average ears, which in turn slightly affected the headset's active noise cancellation. Speaking of, the ANC is pretty good, if not market-leading, and only has on/off/ambient settings.

The headphones connect over low-energy Bluetooth 5.3, which most modern phones support, and offer 80 hours of battery with noise cancellation, or 100 hours without. The package also comes with a small USB-C dongle, which allows for a lot more features supported by Creative's software, including preset settings for modes (game, movie, etc), as well as individual games (*Apex Legends*, *Fortnite*, etc). It also lets an unlimited number of other Bluetooth devices connect to the same audio source, which is neat if you're sharing a screen on a train journey, for example.

General audio quality is good, if not great, but bearing the price in mind, they offer great value for money. Music playback is particularly bass-heavy, to the point where the highs and mids can be drowned out. Things are better when you use SXFI via the included dongle. You can enable some accurate virtual surround effects, and useful gaming features such as Scout Mode, which emphasizes footsteps in shooters. Creative's PC software makes tweaking easy, but we found the Android SXFI app basically unusable, as it didn't recognize Creative's headset as a compatible model.

Microphone quality is also good, thanks to the fact that there's an included boom mic, which can be attached or detached to the headset as needed. This also means that the headset doubles up as a good option for work-based video conferencing, or even some live streaming, but bear in mind that it doesn't do anything to block out background noises.

The Creative Zen Hybrid Pro SXFI model sits at the top of the Zen Hybrid Pro range, but still only costs $150. The difference is the SXFI dongle, which really does add a lot to the audio features, and as such is the model we'd recommend. It's not the best headset you'll ever use, but it's so feature-rich, so versatile, and such good value for money that you certainly won't feel short-changed if you elect to buy it. **–GUY COCKER**

VERDICT

7

Product Name: Creative Zen Hybrid Pro SXFI

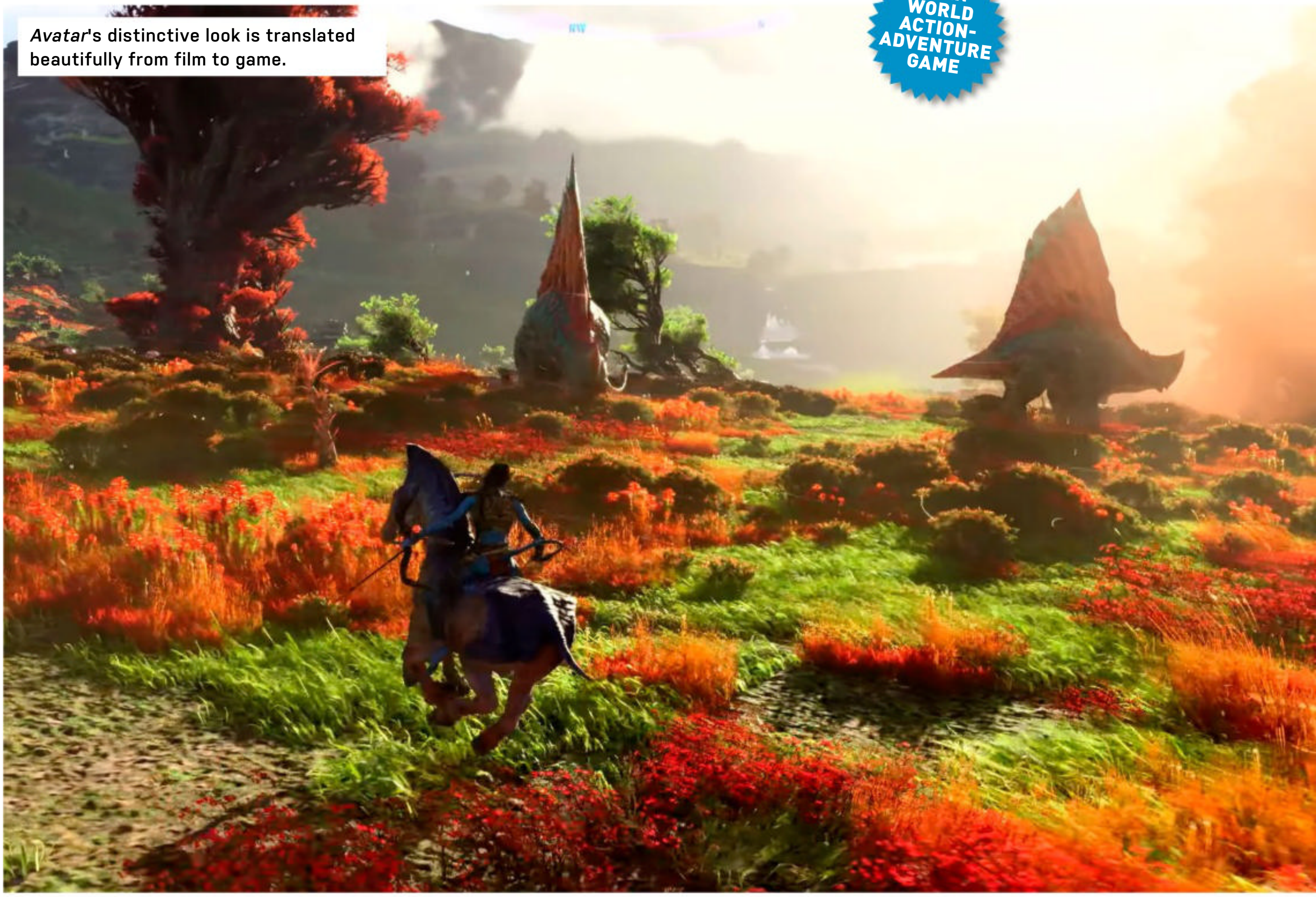
➕ **SEXY-F** Loads of features; Equally suited to PC and mobile use; Gaming presets work well.

➖ **UGLY-FI** Uncomfortable on larger ears; Confusing SXFI mobile app; No USB-A adaptor for SXFI transmitter.

$150, www.creative.com

SPECIFICATIONS

Connection	Bluetooth 5.3, BT-L4 Wireless SXFI Audio Transmitter (USB Type-C Dongle)
Battery Life	Up to 80 hours (ANC on), 100 hours (ANC off)
Charging Cable	USB-A to USB-C
Color	Black
Warranty	2 years
Dimensions	151 x 80 x 184 mm
Weight	282g



Avatar's distinctive look is translated beautifully from film to game.

OPEN WORLD ACTION-ADVENTURE GAME

Avatar: Frontiers of Pandora

A good Far Cry with big problems

FULL-ON SYSTEM CRASHES, poor performance, and bizarre progress erasing interface bugs involving a perpetually grayed-out 'continue' button that only works when the game is deleted and subsequently reinstalled. It's been an inauspicious start for *Frontiers of Pandora*, but we kept hammering away, and it turns out that it was worth it. This could be the best *Far Cry* game Ubisoft has ever published.

Much like *Far Cry* itself, resource gathering is the primary means by which you source special ammunition and craft materials for new gear, but *Frontiers of Pandora* puts an environmentally conscious twist on what would otherwise be a purely extractive (colonial, even) approach to harvesting. Killing a deer quickly or gently removing the fruit from a tree will yield higher-quality resources, which can be donated to the communal baskets at the various Na'vi clan hometrees.

Okay, it can be a bit corny. When you take down your first Sturmbeast (a six-legged dinosaur buffalo) and your Na'vi says a short prayer to Eywa, thanking her for sharing her gifts, it's a bit of an eye roller. Still, the minimalist user interface and emphasis on exploration is a welcome departure from Ubisoft's traditional approach to open-world design. Objective markers only show up when you engage Na'vi senses, which makes your time on Pandora mostly peaceful, but occasionally punctuated by intense combat.

Your arsenal is a blend of Na'vi and human weaponry: longbows and bigger, heavier longbows, lacrosse sticks that lob grenades and poison traps, as well as assault rifles and shotguns. It's a fun mix of weapons that each fill a particular niche. There's a great moment early while facing five mech suits that has you switching between weapons à la *Doom Eternal*—lobbing grenades to knock them off balance, cracking their dumb Ford F-150 windshields with arrows, and then spraying down the pilot with a quick burst from your AR, all while bobbing and weaving between deafening volleys of autocannon fire.

Na'vi physiology brings with it a whole suite of changes to the *Far Cry* formula, the best being a charge and double jump that takes advantage of Pandora's density. Navigating the world is a total joy, sprinting at mach five across the

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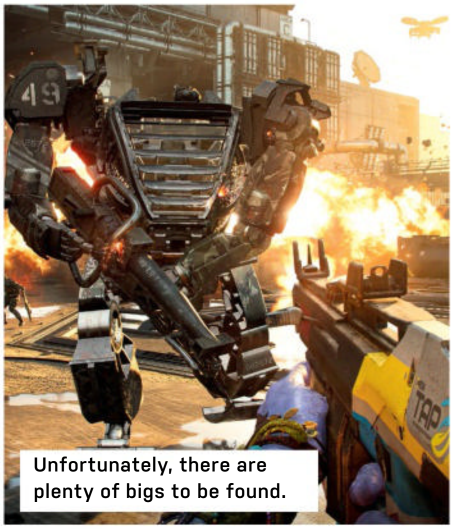
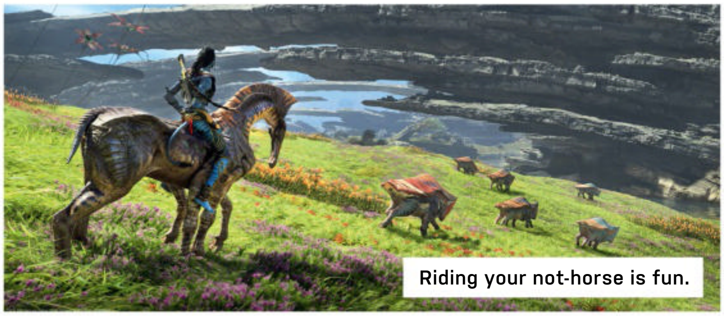
The human versus Na'vi narrative of *Frontiers of Panadora*'s first act is a little tone-deaf.



Unfortunately, there are plenty of bigs to be found.

Frontiers of Pandora puts an environmentally conscious twist on what would otherwise be an extractive approach to harvesting.



Riding your not-horse is fun.

Your arsenal is a blend of Na'vi and human weaponry, from longbows to assault rifles.

forest floor and parkouring across the serpentine tree roots that connect dense jungle brush to wide open plateaus.

These environments, by the way, are jaw dropping. Avatar's psychedelic '*Ecco the Dolphin* color palette meets Starship Troopers industrial sci-fi' look is translated beautifully from film to game. That said, the narrative of *Frontiers of Pandora*'s first act is rather jarring, awkwardly written, and tone-deaf. At the first human resistance base, your Na'vi character will be subjected to endless inane babbling.

There's constant gawking and cracks about the differences between human and Na'vi physiology, and without the option to push back, it just comes off as a thoughtless backing track of microaggressions that will likely be uncomfortably familiar to any Indigenous person. Meanwhile, the invading RDA, who in the films are a modern-day mining company run by a neoconservative Judge Holden, also feel like they've had all their edges sanded off. Their unflinching brutality is only ever alluded to, which just adds to the uneven feel.

If the game does work for you, and it appears Nvidia GPU owners have had a better time than AMD users, then this is one of the best technical showcases in PC gaming. The world is beautifully presented, all fauna shaking in the wind, light blooming through the trees, and water effects to die for.

Though the narrative Ubisoft has crafted to stand alongside Cameron's is at best baffling and at worst offensive, the consistently engaging and immersive open world feels like a step forward from a publisher whose open-world games often seem intent on wasting your time. Though our time on Pandora has been rife with technical and performance issues, it's been the most fun we've had with one of these games since *Far Cry 3*. Fingers crossed that the day one patch resolves most of the technical issues, there's a great game trying to escape the bugs. **–NOAH SMITH**

VERDICT
8

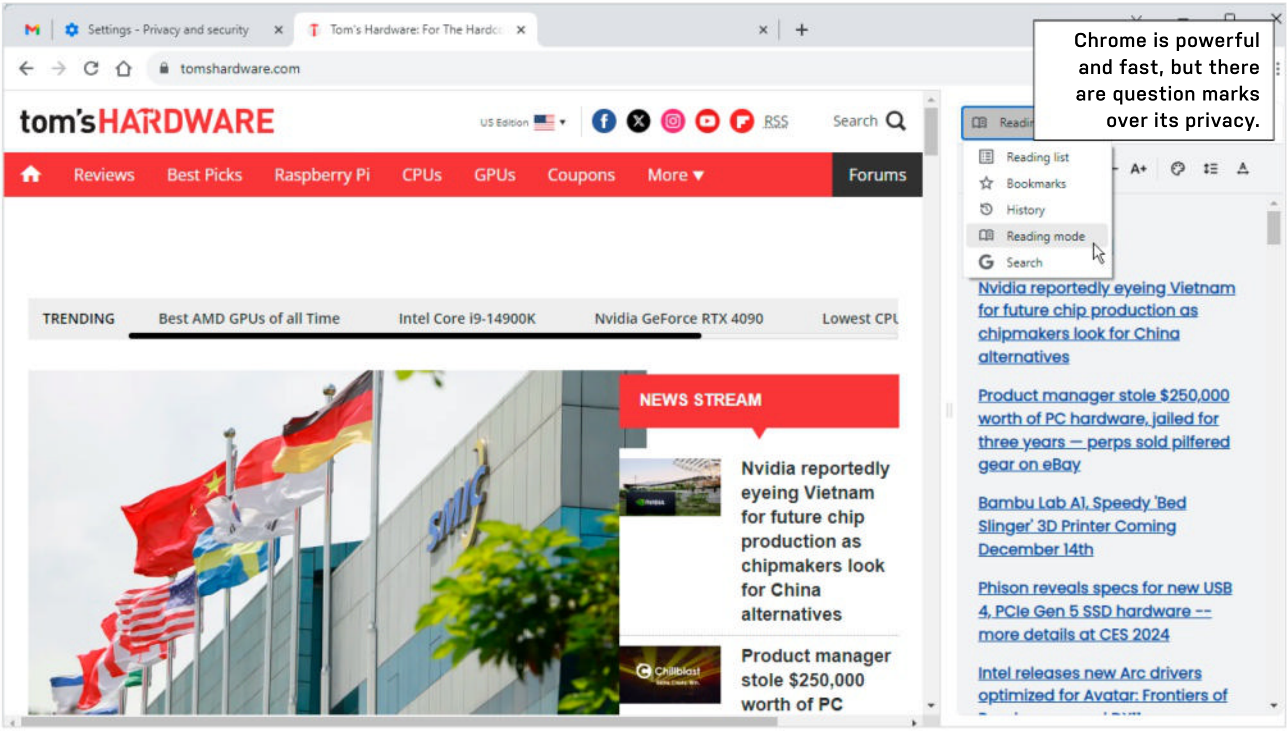
Avatar: Frontiers of Pandora

GOOD SHOUT Much improved open-world design; Good weapons; Great visuals.

FAR CRY Very buggy broken; baffling, borderline offensive narrative.

RECOMMENDED SPECS CPU, AMD Ryzen 5 5600X / Intel Core i5-11600K. GPU, AMD Radeon RX 6700 XT / NVIDIA GeForce RTX 3060 Ti. RAM, 16GB.

$69.99, www.ubisoft.com/en-gb/game/avatar/frontiers-of-pandora, rated 16



Nvidia reportedly eyeing Vietnam for future chip production as chipmakers look for China alternatives

Product manager stole $250,000 worth of PC

Nvidia reportedly eyeing Vietnam for future chip production as chipmakers look for China alternatives

Product manager stole $250,000 worth of PC hardware, jailed for three years — perps sold pilfered gear on eBay

Bambu Lab A1, Speedy 'Bed Slinger' 3D Printer Coming December 14th

Phison reveals specs for new USB 4, PCIe Gen 5 SSD hardware -- more details at CES 2024

Intel releases new Arc drivers optimized for Avatar: Frontiers of

Chrome is powerful and fast, but there are question marks over its privacy.

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Google Chrome vs Firefox

One's a behemoth, the other an old(er) pretender

WHEN IT COMES to browsing the web, more than six in ten of us use Google's Chrome browser. Its dominance has slipped slightly in recent years, but that only tells part of the story. Beneath Chrome's hood is Google's open-source Chromium browser and Blink web engine, which renders web pages and performs other core tasks, including navigation, running scripts, and security. Virtually all other web browsers—including Microsoft Edge—now use Blink rather than develop their own proprietary engines.

While Apple continues to plow its own furrow with WebKit, the only other standout is Mozilla's Gecko engine, used to power its Firefox browser. Unlike virtually any other browser comparison, then, we're not simply splitting hairs between two browsers who share large portions of code from the open-source Chromium browser project; we're genuinely comparing apples and pears.

Any comparison, then, must start with Blink and Gecko. For the most part they work in a practically identical manner, so when you open a website in either browser, you see no difference. Behind the scenes, however, there are many differences—in the past, websites often produced multiple versions of a web page, each one optimized for a different browser or web engine.

Those days are long gone, and one reason why so many browsers have switched to Blink is because most sites focus solely on producing pages that work with it. Gecko does its best to keep up, but there are some pages that won't load properly (if at all)—however, Firefox users can simply try the pages in Edge without having to go near Chrome at all, although it's obviously still a faff.

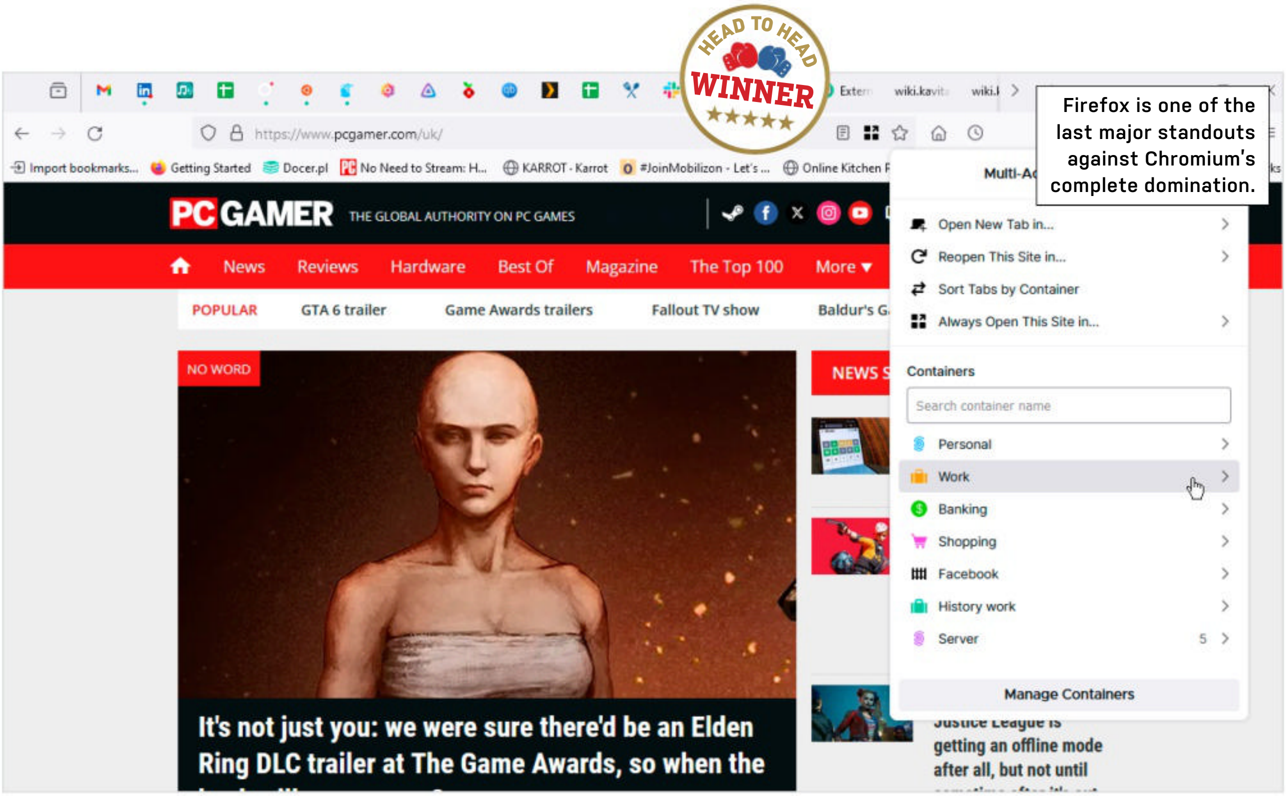
Chrome also wins hands down when it comes to raw performance, outpacing Firefox by an average of around 40 percent in our tests using the three benchmarks at Browserbench.org. This translates to faster loading times and a snappier experience overall, but in the real world this is small beer—Firefox is perfectly responsive and fast enough in everyday use.

It's at this point that Chrome starts to lose its luster, thanks in no small part to Google's own practises around security and privacy. For example, the behemoth has long threatened to remove the functionality that allows ad-blockers to fully block ads on web pages, and it looks like this may finally come to pass this year. Google has also been rolling out plans to kill off tracking cookies, but this isn't an act of altruism; it plans to use its own tracking mechanisms instead. This should not be surprising for a company that dominates the web advertising and user profiling sphere.

In stark contrast, Mozilla stands firmly in the court of online privacy, as evidenced by its own Enhanced Tracking Protection tools, which have evolved over time to offer a wide range of options for blocking unwanted trackers. A recent addition is Total Cookie Protection, which prevents cookies from being able to follow you from site to site. Users can also experiment with even more restrictive settings at the risk of breaking some sites' functionality (you can then whitelist those sites or take the hint to steer clear).

THE BROWSER EXPERIENCE

Moving away from the underlying engine to the browsers themselves, both Chrome and Firefox offer a similar subset of core features. Both pioneered tabbed browsing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Reopen This Site in...
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Always Open This Site in...
Containers
Search container name
Personal
Work
Banking
Shopping
Facebook
History work
Server
5
Manage Containers

It's not just you: we were sure there'd be an Elden Ring DLC trailer at The Game Awards, so when the

Justice League is getting an offline mode after all, but not until

Firefox is one of the last major standouts against Chromium's complete domination.

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and allow you to sign into an account (your master Google account in Chrome, a dedicated Mozilla account in Firefox) to sync settings, passwords, add-ons, and tabs across all your devices—including mobile. Both feature well-stocked add-on stores for increasing the browser's functionality beyond the basics too.

Chrome scores additional points for natively supporting multiple profiles, which you could use on a solely personal level—for example, to separate work and home life—or to share the browser with multiple users on a single PC. There's even a 'Guest' option for temporary access, ensuring your settings, tabs, and bookmarks remain private.

While not present in Firefox natively, you can gain this per-user sharing experience with the Profile Switcher for Firefox add-on. However, Mozilla also offers its own official Multi-Account Containers add-on, which allows you to separate various parts of your life into individually color-coded containers. Each container houses its own tabs and login details (so you can log into the same service with different accounts), plus each container is sandboxed from the others, allowing you to contain trackers within each silo. You can even integrate your containers into Mozilla's paid-for VPN or your own proxy setup for both security and geographical reasons (you could, for example, have one container sited at home, and the other for abroad, giving you access to local sites and currencies).

It's worth pointing out that neither Chrome's native features nor Firefox's add-ons can hold a torch to Vivaldi's Workspaces/Tab Stacks feature for bringing order to dozens of chaotic tabs.

As you'd expect from two venerable browsers that share a similar feature set, there's also little to choose between them on the user interface front. Chrome feels sleeker and simpler—the side panel providing one-click access to history, bookmarks, synced tabs, and so on is a nice touch, while Firefox offers one-click access to your history (and tabs) only.

One honorable mention should go to Firefox's integration with Pocket, which stems back to Mozilla's partnership with (and then acquisition of) Pocket. The free account lets you save a simple list of content to return to later, while Premium adds a permanent library, full-text search and unlimited highlights, among other things. It's a good feature that outclasses Chrome's simple Reading List option, but given you can add Pocket to Chrome via an extension, it's not the killer feature it might otherwise be.

Long story short, there's very little to differentiate the two when it comes to features and user experience. This leaves you choosing between performance—Chrome wins comfortably—or privacy and the open-source ethos, and here, of course, Firefox is the victor. You might be tempted to try a more privacy focused Chromium browser like Vivaldi or Brave to bypass Google, but striking a blow for open web standards in 2023 means rejecting Chromium altogether, and that means choosing Firefox.–**NICK PEERS**

VERDICT 7

Google Chrome

CHROME PLATED The closest thing to a standard browser; Fast and compatible.

TARNISHED CHROME Tied into Google's ecosystems; So-so privacy tools.

RECOMMENDED SPECS Any PC running Windows 10 or later.

Free, partially open-source

VERDICT 8

Mozilla Firefox

FOXY LADY More user-focused privacy controls; Completely open source; Configurable.

OUTFOXED Not 100 percent compatible with some sites; Not as fast as Chrome.

RECOMMENDED SPECS 1GHz processor, 2GB RAM, 500MB HD space, Windows 10 or later.

Free, open-source

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> RAM Latency
> NZXT AIO Pricing
> Windows Licenses

4 sticks vs 2?

Can I please get you to clarify something for me? In the final critiques of your many great builds, you often include a line to the effect that "going from two to four RAM modules would look nicer", particularly when RGB is involved.

Now, I've long had the impression that fully populating all four DIMM slots will lead to reduced performance (it's just not possible to achieve high speeds or low latency using all slots, especially if using higher-capacity modules). Is this still accurate?

If so, might I suggest you include that disclaimer and make more explicit that you're favoring visually appealing symmetry/lighting over ultimate performance?

Thanks, and keep up the great work! **–K. Weppler**

GUEST HARDWARE EDITOR, ZAK STOREY, RESPONDS: This is quite an interesting question, and it sort of harkens back to a time before, when quad-channel kits were all the rage on more premium solutions, such as Intel's enthusiast platforms, and eventually AMD's Threadripper series as well.

For those that don't know, It's less to do with a drop in performance, and more to do with identical performance. So you might expect if you add two additional RAM sticks into the mix, that you'll get twice the bandwidth, better latency, and so on. The reality is you don't. This is because most modern CPUs are locked into that dual-channel specification (basically, any Ryzen or Intel series of the last five gens or so), so it can only read and write data to two of those sticks at any one time.

That means you could have a motherboard with 12 DIMM slots, populate the lot, and you'd still only get the memory bandwidth of two sticks. Memory bandwidth is one of the ultimate deciding factors on the performance of your memory kit, as it indicates how much data can be written or read from your DIMMs at any one time.

Latency, on the other hand, is how long it takes for those individual memory requests to be received and actioned. Now, this is where it gets tricky. Theoretically, if you add more DIMMs, your CPU could accidentally split the data it stores on RAM across multiple sticks. Most DIMM slots are set up as pairs for optimized traces to the CPU, so you have memory in A1, B1, A2, and B2 (the number donating the pair). Also, your CPU stores a command or connected resource partly on B1 and partly on A2. There is a chance that it could increase latency, as you're effectively pulling data from two unoptimized pairs of memory. That said, CPUs and Windows have come a long way in the last few years, with resource allocation a focal point, so I imagine this is somewhat non-existent now.

The tl;dr is that it used to be an issue, but these days, it's not likely to cause any major problems. The bigger detriment to performance, particularly looking at latency, is how slow CAS latency currently is on DDR5. Yes, we've got far faster kits pushing 8,000 MT/s now, but we've also got CAS latencies up in the 30-40 range, versus DDR4's 14-20s. So from a purely latency perspective, we've not seen any major improvement over DDR4 outside of more capacity.

If you're still not convinced though, you can always stick with two DIMMs instead, and opt for a set of dummy RGB sticks. There are a few manufacturers who make them for specific memory kits in their line-ups. They look like whatever model they're mimicking with full RGB compatibility, just without the RAM hardware you'd expect.

That said, it's a really interesting point nonetheless, kind of like the 'do you need an Intel Core i9 for 4K gaming' angle we've ran in our cover build. It's definitely worth some testing, for sure. We've actually got a full-on RAM review coming next issue (written by yours truly), with a full set of benchmarks attached. This should shed some light on this situation as well, as the benchmarks are comparing a 7200 C34 kit to a 6000 C30 kit (real-world latencies of 9.44 and 10 ns respectively between the two).

↘ submit your questions to: editor@maximumpc.com

NZXT Cooler Mishaps

I still think that after looking at the prices of 360mm AIO cooler kits at NewEgg, $300 for an NZXT kit is excessive. However, I do understand the struggle you have in the UK with supply chain issues and dollar exchange rates.

Clearly, having a piece of kit that works but is expensive is better than another kit that fails, but I am disappointed that so many kits failed! I've never had an AIO failure. Perhaps they've just become too complex with all the silly front-screen displays, RGB lights and so forth.

Also, isn't it ironic that the Turbo AMD blueprint is more powerful and less expensive than your cover build in the December 2023 issue? Perhaps you should have gone for power instead of bling! **–R. Matlow**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: That's the unfortunate 'perk' of being a tech journalist. We often get access to press samples, early engineering units, and more. Sadly, these don't quite have the same quality control as the retail units that you'd find in-store or online.

If you speak to any of the *Maximum PC* team past or present, they'll regale you with an arsenal of stories of componentry they've trashed, broken, or burnt out while working here (or continue to do so today). It's just part and parcel of how we work, admittedly. The good folk at NZXT, Corsair, Phanteks, Noctua, and more always step up though, and make sure we have the parts to hand, and we often work closely with them if we do identify an issue ahead of time.

There have been a few products that have been entirely recalled because of good tech journalists catching faults and bugs before they hit the market. It might cost the companies in question millions in recalls, but it's far better than having a defective product in the hands of customers.

As for the RGB bling and price point, you're right—it is a pricey little number. That particular unit is approaching EOL as well, despite being so popular, which is why the price is as high as it is. There are a number of 360mm alternatives out there though, including Be Quiet!'s Pure Loop 360 at around $100 or EK's AIO Basic 360 (what a name) at $129, and they should offer almost identical performance (albeit with a degree or two difference here and there) comparatively.

As for the Turbo build, that's always meant to provide an alternative to what we produce in the mag. It's more about the core components really, rather than the bling we add on top. It's never meant to be the absolute top-tier system money could buy. Likewise, budget isn't as cheap as physically possible either. We aim for three different price points for them and try to get as close to those as we can, without sacrificing performance wherever possible, and making sure you get the best bang for the buck if you do decide to go for that route.

This issue has seen a hefty number of alterations to blueprints though, which should tighten up the pricing and performance of all six builds.

Windows 10 For Cheap?

The Builds section shows Windows 10 Operating System at $32, but I cannot find this operating system at this price. Can you confirm where this price is coming from so I can purchase it for my build? **–J. Bell**

GUEST HARDWARE EDITOR, ZAK STOREY, RESPONDS: Yes, so first up this is 100 percent a legitimate license, and a way of activating Windows. It is completely legal and above board. You can buy individual OEM licenses for Windows 10 or 11 for that matter from most key-sellers.

Places we typically use when building one-off systems for family and friends are g2a.com and kinguin.net. Just looking at G2A right now, Windows 11 Home will set you back $26 for a Win11 Home key before taxes. Generally, they average around $32 or so on the whole.

The way these keys work is they're a one-off activation code. So it's a one-time deal. If you heavily change the hardware in the machine or try to use it a second time after say you reformat it, it's not going to activate, as it was a one-time activation. If you're on a budget, it's a fantastic quick-fire solution.

This is actually one of the reasons I recommend, as a tech enthusiast—you buy a full license from Microsoft directly and tie it to a digital account (mine's tied to my Gmail account). Until very recently, I was still using a Windows 8.1 Pro Student license (it was $50 at the time of purchase while I was still at college), to activate my personal machines, (this is with Windows 10 or 11 already installed, there's no janky upgrade paths or anything along those lines). I'd purchased that way back in 2013. Sadly, Microsoft has only just recently stopped Windows 8 and 8.1 codes from upgrading that far, so I finally had to fork out $140 for a Windows 11 digital license. But hopefully that'll last me another 10 years.

Bearing in mind that I've had 13 separate personal systems at home since picking that full license up, even at full price that's saved me close to $300 in the long run, not counting the numerous times I've swapped out hardware, or reformatted the PC several times over (I recommend a complete reformat of Windows at least once every six months to clean up the registry and remove any unwanted programs you've forgotten about).

Radio Shack Lives!

In your May 2023 article 'CPU Architectures - What's the Difference and Why it Matters', you had a sidebar called 'Gone but not Forgotten'. You forgot to mention one of the biggest users of the Zilog Z80—The Radio Shack Tandy TRS-80 model I and model III... **–T. Kirner**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Wow, yeah we totally forgot about that. It's easy to forget about some of these systems, particularly with the way the industry has gone. The Zilog Z80 was an incredible piece of machinery. It's a shame that there are not more processor manufacturers, although understandable given just how much investment is required to produce modern-day transistors smaller than blood cells.

There's a fantastic image on the Wikipedia page for the Radio Shack Tandy TRS-80 that shows it side-by-side with the Commodore PET, Apple II, and TRS-80 Model I. There truly is a beauty to these older machines. Heck, I'd argue it's actually classier looking than the other two.

It's one of those products we'd love to get in and do a deep-dive on, or a stealth-build in something similar, but honestly, that might just be a bit too much desecration for our taste.

THE BUILDS

THIS MONTH'S STREET PRICES...

WE'RE IN THAT WEIRD in-between space right now where parts are coming in and out of circulation. Intel's 14th gen has just landed, and new AMD chips and Nvidia GPUs are on the horizon, so the market is struggling to decide what goes on offer, and what the pricing of products should be. That puts us in an awkward position when it comes to selecting parts for our blueprints. Nevertheless, we've purged some of the more chaotic parts in favor of a few choice component upgrades instead.

Our AMD system had the biggest shake-up, with six new components, alongside a platform change. Yup, we blew away the Ryzen 5 5600, and replaced it with its successor chip, the 7600. This means a new socket and an AM5 motherboard, alongside some sweet DDR5. Fortunately, they're all good picks, and despite being on the bottom end of the budget spectrum, these will do you well in professional and gaming-oriented tasks. According to our testing, that RX 7600 is a pretty solid unit, more than capable of maintaining 60 fps and above on Ultra at 1080p.

Intel also got hit by the build hammer—again this was mostly down to the market fluctuating. The changes were less dramatic, but we did grab some speedier memory, alongside a slight downgrade to the RTX 4060. That said, the 4060 is a solid unit, and clocks average frames in most games close to 100+.

To balance the books, we've changed our storage solutions. It's about time we called EOL on those pesky HDDs. Don't get us wrong, if you need a full NAS solution, they're still valuable, but with the advent of cloud storage, and cheap and affordable M.2s and SSDs, it's hard to justify a big bulky 3.5-inch spinning disk. That said, both builds benefit from 2TB of crisp, clean PCIe 4.0 storage. Sadly, only the Intel board will run both drives at full speed, so the AMD board is definitely a 'buy now, upgrade motherboard later' (although you still get PCIe 3.0 speeds).

AMD INGREDIENTS

PART		PRICE
Case	Corsair 4000D Airflow	$95
PSU	600W Thermaltake Toughpower GX2 80+ Gold	$69
Mobo	Asus Prime A620-Plus WiFi ATX AM5 **NEW**	$140
CPU	AMD Ryzen 5 7600 **NEW**	$194
GPU	XFX Speedster Swift 210 Core RX 7600 8GB **NEW**	$260
RAM	16GB (2x8GB) Teamgroup Elite Plus DDR5 @ 4800 **NEW**	$48
SSD 1	1TB MSI Spatium M450 PCIe 4.0 M.2 **NEW**	$58
SSD 2	1TB Teamgroup T-Force Cardea Z44L PCIe 4.0 M.2 **NEW**	$51
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32

Approximate Price: $947

INTEL INGREDIENTS

PART		PRICE
Case	Corsair 4000D Airflow	$95
PSU	600W Thermaltake Toughpower GX2 80+ Gold	$69
Mobo	ASUS Prime B760-Plus ATX **NEW**	$138
CPU	Intel Core i5-12400F	$146
GPU	Gigabyte Windforce OC RTX 4060 8GB **NEW**	$300
RAM	16GB (2x8GB) Patriot Viper Venom DDR5 @ 5200 **NEW**	$62
SSD 1	1TB MSI Spatium M450 PCIe 4.0 M.2 **NEW**	$58
SSD 2	1TB Teamgroup T-Force Cardea Z44L PCIe 4.0 M.2 **NEW**	$51
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32

Approximate Price: $951

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MID-RANGE

COMETH THE HOUR, cometh the mid-range, and here we are with another barrage of new components. Like our budget-build, it's been a challenge finding the right components without stretching the price too far. That said, we've made some subtle changes that should impact performance pretty solidly.

AMD is up first on the chopping block. We ditched the 7600X in favor of the 7700X for the additional cores, then pushed for a better mobo in the form of MSI's PRO X670-P, alongside a more modern GPU: the 7700XT. The latter's a solid unit, averaging around 60fps at 1440p. The VRAM is a minor concern for long-term performance, but we're confident it'll hold for the next few years. This is one area we would recommend pumping in a bit more cash, however, as the rest of the system is solid, and we're arbitrarily setting ourselves a $1,500(ish) limit for both builds.

As for Intel, we've chucked out the 13600K in favor of our CPU pick this issue, the 14600K. It's proven its worth, and given the 13600K is now almost out of stock everywhere, it's a matter of time until it's extinct good and proper. We've also saved enough cash by swapping to the slightly lower-spec 4060 Ti (the 4070 deals have all vaporized) to plump for a beefier cooling solution, upgrading to a 360mm AIO. But didn't we just say that 12GB of VRAM was cause for concern? Yep. Doesn't that GPU have 8GB? Yep. If you can, get the 16GB variant instead. You'll still find yourself comfortable at 1440p, but more VRAM is always better.

As for shared componentry, we've pumped both builds up with a new PSU, with an 80+ Gold rating instead of the Bronze EVGA unit, and gone for a beefier secondary SSD, ditching the HDD for a 2TB PCIe 4.0 drive. You'll also note that we've opted for two (different sets) of DDR5 memory. Both pump 32GB of 6000 MT/s memory out the gate, and should be more than enough for any video-rendering tasks or more creative avenues of fun.

AMD INGREDIENTS

PART			PRICE
Case	NZXT H7 Flow		$124
PSU	750W Corsair RM750e - 80+ Gold	NEW	$100
Mobo	MSI PRO X670-P WiFi ATX - AM5	NEW	$195
CPU	AMD Ryzen 7 7700X	NEW	$339
Cooler	Be Quiet! Pure Loop 2 - 240mm AIO	NEW	$90
GPU	PowerColor Fighter OC Radeon RX 7700 XT 12GB	NEW	$420
RAM	32GB (2x16GB) Corsair Vengeance RGB DDR5 @ 6000	NEW	$105
SSD 1	1TB Lexar NM790 PCIe 4.0 M.2 SSD		$71
SSD 2	2TB Gigabyte Aorus Gen4 5000E PCIe 3.0 M.2 SSD	NEW	$86
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)		$32
Approximate Price:			**$1,562**

INTEL INGREDIENTS

PART			PRICE
Case	NZXT H7 Flow		$124
PSU	750W Corsair RM750e - 80+ Gold	NEW	$100
Mobo	MSI Z790 Gaming Pro WiFi ATX	NEW	$210
CPU	Intel Core i5-14600KF	NEW	$303
Cooler	EK AIO Basic 360 - 360mm AIO	NEW	$129
GPU	MSI Ventus 3X OC RTX 4060 Ti 8GB	NEW	$405
RAM	32GB (2x16GB) Teamgroup T-Force Vulcan DDR5 @ 6000	NEW	$87
SSD 1	1TB Lexar NM790 PCIe 4.0 M.2 SSD		$71
SSD 2	2TB Gigabyte Aorus Gen4 5000E PCIe 3.0 M.2 SSD	NEW	$86
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)		$32
Approximate Price:			**$1,547**

TURBO

THINGS ARE HEATING UP in Turbo land with the arrival of Intel's 14900K, and AMD has responded, and responded hard. The 7950X3D is down to an incredible $566 to combat Intel's Core i9 pricing. Whether that's enough to entirely stem the tide is unknown at this point, but it just goes to show how much AMD considers the 14th gen a threat, despite its lackluster arrival.

In other news, it's staggering to us just how affordable 4TBs of PCIe 4.0 SSD are these days. $189 for a heck of a solid M.2 from Teamgroup—that's not too shabby at all. Okay, it's not 6TB of spinning platter (you do lose out on that 2TB extra, and a bit of cash), but the read and write speeds are more than worth it.

We've made some big changes across the board once more, opting for a 1200W PSU across both builds and tweaking the motherboard selections to provide a better serving of I/O for those premium professionals out there. Additionally, we plumped for an LCD cooler (which was weirdly cheaper than the non-LCD variant), and also changed the primary SSD over to a PCIe 5.0 solution instead. (Just remember to stick it under your motherboard's heatsinks please, as these things run hot.)

As for AMD, changes have been fairly minimal. We've gone for a slightly speedier DDR5 kit to better benefit from Ryzen's Infinity Fabric memory scaling capabilities. We've also grabbed a slightly higher spec 7900XTX to ensure that 4K gaming stays resolutely in the 80-90 fps range.

For Intel, we've gone a bit of a different route, dropping the 14900K for the KF variant instead, and going for a 16GB PNY RTX 4080 (again to hit that 4K 80fps mark). But the biggest change by far is the memory kit. G.Skill has a fantastic trident Z5 kit available running @ 6800 CL34 (ideal for that memory controller in the 14th gen), it's even cheaper than the 6000 CL30 in the AMD build. What's the catch? Well, it's a 48GB kit. Yep, we're doing that now. Earlier this year, a number of manufacturers jumped on the 24GB DIMM stick bandwagon. It provides a fantastic sweet-spot in the DDR5 ranges right now, particularly with the larger capacities, and can save you money, too.

AMD INGREDIENTS

PART			PRICE
Case	Phanteks Enthoo Pro 2 Tempered Glass		$145
PSU	Be quiet! Straight Power 12 1200W - 80+ Platinum	NEW	$240
Mobo	Asus Prime X670E-Pro WiFi ATX - AM5	NEW	$326
CPU	AMD Ryzen 9 7950X3D		$566
Cooler	NZXT Kraken Elite 360 RGB - 360mm AIO	NEW	$286
GPU	Sapphire Nitro+ RX 7900 XTX 24GB	NEW	$1,060
RAM	64GB (2x32GB) Corsair Vengeance RGB DDR5 @ 6000 CL30	NEW	$205
SSD 1	2TB Corsair MP700 PCIe 5.0 M.2	NEW	$240
SSD 2	4TB Teamgroup T-Force Cardea Z44Q PCIe 4.0 M.2	NEW	$189
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)		$32

Approximate Price: $3,289

INTEL INGREDIENTS

PART			PRICE
Case	Phanteks Enthoo Pro 2 Tempered Glass		$145
PSU	Be quiet! Straight Power 12 1200W - 80+ Platinum	NEW	$240
Mobo	Gigabyte Z790 Aorus Elite AX-W ATX	NEW	$360
CPU	Intel Core i9-14900KF	NEW	$546
Cooler	NZXT Kraken Elite 360 RGB - 360mm AIO	NEW	$286
GPU	PNY Verto RTX 4080 16GB	NEW	$1,150
RAM	48GB (2x 24GB) G.Skill Trident Z5 RGB DDR5 @ 6800 CL34	NEW	$170
SSD 1	2TB Corsair MP700 PCIe 5.0 M.2	NEW	$240
SSD 2	4TB Teamgroup T-Force Cardea Z44Q PCIe 4.0 M.2	NEW	$189
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)		$32

Approximate Price: $3,358

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